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THE CANADIAN RAILWAY COMMISSION.

By J. G. G. Kerry.

No problem presses more strongly for solution in the United States than the regulation and control of the railway corporations. Some few still hold to the doctrine of "laissez faire" and would leave the corporations entirely to their own devices; others see in government ownership the only remedy for existing evils; but the mass of intelligent public opinion rejects both of these solutions, fearing alike the influence of private greed in the first and of political interest in the second. The most satisfactory solution of the problem is apparently to be found in the establishment of a just and firm system of government control, removed as far as possible from the evils of political influence, short tenure of office, and the temptations of insufficient salary, while retaining to the management of public-service corporations the progressiveness and initiative of private enterprise. The Canadian system of railway regulation is one of the most notable examples of government control along these lines, and the following paper by one who has been in close touch with the operation of the system has a peculiar and timely interest.—THE EDITORS.

THE history of the English race is the history of a long conflict for individual liberty. Our forefathers succeeded in winning for us civil and religious liberty in such measure of fullness that we sometimes fail to value our heritage, but they left the battle for financial independence for us to fight. Probably the power of the financial kings was never before so thoroughly consolidated and organized as it is today and never became a cause of unrest and vague fear to the mass of the people. That there is any sound reason for the existence of this vague fear, which is the true cause of the popular outcry against corporations, is a much debated question, and the corporations have most sincere advocates and most sincere opponents. It is, however, certain that the only law that the great majority of men accept without question is that they must earn their daily bread and they fear that the growth of the great financial and industrial corporations will make this task increasingly more difficult,

Some form of public control of industrial corporations is, therefore, generally desired, but it would be hard to get any large number of men to agree among themselves as to the extent to which that control should be exercised. The prominent wage earner and public-ownership advocate of today may be the corporation promotor of tomorrow, and his position on economic questions, if he be honest, cannot fail to change rapidly with his broadened outlook and his altered fortunes. But however the opinion of the individual may vary, it must be admitted that this question of effectively controlling corporations is perhaps the most important question of our national life today, and that any comprehensive effort to solve it is worthy of close observation and study.

The control of the Canadian railway corporations—and the law is being gradually amended to cover all transporation corporations—through the Board of Railway Commissioners is a notable example of such an effort. It is modelled on that solution of the problem which is advocated by those who hold that any undertaking is best managed by men whose personal advancement is directly dependent upon the success of the enterprise, and upon that alone. These thinkers admit that it is beyond question that the public official will, in many cases, be the equal or the superior of the employee of the private corporation in intelligence, integrity and industry; but they doubt whether he can fully and impartially devote his energies to the public service and still be certain of that recognition and reward which comes to all men of capacity who work steadily and faithfully for a well-managed private corporation. If the doubt is well founded and there are many examples to be quoted in support of it, then the abler and more forceful men will not find it to their interest to remain long in public service, and with their resignations the efficiency of that service will fall off.

This is the position of the Canadian publicist of today on transportation questions, and his legislation is shaped on the conviction that the products of the country can be most efficiently and economically handled by private corporations specially chartered for the purpose. But as it is necessary to grant very great privileges and powers to these corporations so that they may efficiently organize their systems, it is also held to be necessary to check the abuse of these powers, and to secure satisfactory service by restrictive legislation intelligently enforced. The machinery for enforcement has been provided by the creation of the Board of Railway Commissioners.

The method of appointment of this Board, its organization,

jurisdiction, duties and powers are set forth in what is generally known as "The Railway Act of 1903" (Revised Statutes of Canada 1906, Chapter 37). This Act was itself simply a revision and a complete re-statement of the existing railway law of the Dominion and was drawn up under the direction of the late Hon. A. G. Blair, then Minister of the Department of Railways and Canals and a member of the Canadian Cabinet. At that time Mr. Blair had been for some seven years ex officio the chief executive officer of the Canadian Government lines, and responsible for the operation of about 1500 miles of railway. It was recognized that the revisions and proposed alterations included very material departures from established practice, and the clauses of the Act were therefore very fully discussed in the Committees of the Houses of Parliament. Also, advance copies of the Act were furnished to the railway companies who on their part organized joint committees representing each of the great departments of railway organization, and to each committee were submitted for criticism and report all the clauses bearing upon the work of that particular department. The objections taken by these committees were considered during the discussion of the legislation.

The result of this careful revision of the law was the creation of a Commission with wider powers over great interests and with greater territories under its jurisdiction than are entrusted to any other similiar commission, and these facts were recognized in the Hon. Mr. Blair's opening speech at the first meeting of the Board. Mr. Blair, who had resigned his post as a Minister of the Crown to become the first Chairman of the Board, in the course of his remarks dwelt on the great authority conferred upon the Board, expressing his desire that that authority should be used with moderation and conservatism, that the procedure of the Board should be as simple as possible and that no legal formalities should deter private interests from appearing before the Commission when in need of its assistance or protection. Broadly speaking, the policy then laid down has been steadily followed.

The Board may be considered as a Court created to try certain cases which arise out of the construction and operation of railways. In particular it has jurisdiction over matters concerning:—

(1) The construction details of new roads or of the improvements undertaken by existing lines.

(2) The crossings of highways, railways, power lines and drainage mains by railways.

(3) The rates that may properly be charged for the various services rendered to the public by the railways, the express companies and the telephone companies.

The Board is also charged with the collection of statistics of operation, with investigations of the operating of the roads, in particular of the accidents occurring on them, and with inspection of equipment. To some extent, also, it has become customary, when public outcry is made concerning any particular item of railway practice, for the Government to request the Board to make a report upon the matter, even if it does not lie within the ordinary field of the Board's activities. The Board, in fact, acts as a special adviser to the Government in matters involving the details of the art of railroading.

It was the expressed desire of Mr. Blair that counsel should not be needed when applications were being made to the Board, but under present procedure practically every case is presented by counsel. So numerous and so varied are the applications in which each large railway company is concerned that they have found it necessary to retain special staffs which practically devote their entire time to preparing for, and attending at, the hearings held by the Board.

The Board itself consists of three Commissioners, who are appointed by the Governor-in-Council for a period of ten years and are eligible for reappointment, it being provided, however, that a Commissioner shall cease to hold office upon reaching the age of seventy-five years.* The Board, through some one of its members, is well qualified to grasp quickly the wishes and needs of nearly every section of the Canadian community. It may be noted that no mem-

* The following is a very brief biographical note of the Commissioners now holding office.

Judge Killam, the Chief Commissioner, was born in the Maritime Provinces. After practising law for a considerable time at the bar of both the Province of Ontario and the Province of Manitoba, he was appointed a Judge of the High Court of Manitoba and was subsequently elevated to the Supreme Court of Canada by the present administration. When the Hon. Mr. Blair decided late in 1904 to resign from the Board so that he might be in a position to re-enter the political field, Judge Killam was selected as his successor.

The Hon. Mr. Bernier, the Deputy Chief Commissioner, is a native of the Province of Quebec, and is a lawyer by profession. He has been a prominent figure in political life and for some years was a member of the present administration, holding the portfolio of Inland Revenue, which he resigned early in 1904 to become a member of the Commission.

Dr. Mills was brought up on an Ontario farm but entered educational life, and after filling various posts with distinction became Principal of the Guelph Agricultural College, an institution maintained by the Province of Ontario, and of such efficiency that its Principal becomes to some considerable extent ex officio the head of the Ontario agricultural interests. Canada is mainly an agricultural country and there was a distinct demand from the farmers as a class that there should be someone on the Board who was in sympathy with them, and who was advised of their grievances.

ber of the Board had been prominent in the railroad world during his previous career. Having in view the great importance to Canada of efficient transportation, in the building up of a country which is as yet settled only along one edge and in which the larger communities are separated by magnificent distances, and also remembering the numbers of that great body of men whose advancement is directly dependent upon the success of the railway companies, it is a fair question whether the Commission should not be enlarged to include some representatives who by thought and training are especially qualified to understand the motives and desires of the railroad men. In support of this suggestion it may be said that there are few classes of men who are more completely absorbed in their professional work, and few whose plans and suggestions are more free from ulterior motives. It is not always recognized that, in the railroad world, the initiative in questions of detail comes largely from subordinate officers, who have no knowledge of the finances of the companies, and whose simple ambition is to make the roads as efficient as possible for the carrying on of their legitimate business. However, as most of the problems that come before the Board are thoroughly technical in nature, it was recognized that there would be need of an advisory staff of practical railroad men, and the Board now has under its direction a considerable number of engineers, inspectors, and investigators, chosen from the engineering, operating, and traffic departments of the railroads. It is the customary practice of the Board to refer every application immediately for report to the expert within whose department the matter lies.

The jurisdiction of the Board extends over all railways that are under the legislative authority of the Parliament of Canada and even the roads that are operating on Provincial charters are subject to the Board in matters pertaining to through traffic, crossings of railways and navigable waters, and criminals acts. The question as to the propriety of granting a Dominion charter to a company which proposes to operate entirely within the boundaries of a Province has not yet been settled by the gradual development of Canadian institutions. All lines of larger importance now endeavor to obtain a Dominion charter, while local electric-railway projects are content to operate on Provincial charters. The Board has all the powers, rights and privileges that are vested in a Superior Court, but an appeal upon matters of jurisdiction may be taken from the Board to the Supreme Court of Canada. All orders of the Board, on appeal, may be varied or rescinded by the Governor-in-Council,

but the proportion of orders so appealed to the number of applications annually dealt with by the Board is extremely small.

Questions of procedure, notice, form of application, etc., are dealt with in the Act, or are prescribed by order of the Board, and great care is taken to see that all legal formalities are properly observed. It is the practice of the Board, when so requested, to hold its hearings at the place most concerned in the application, a practice which necessarily results in considerable delay in dealing with such cases, as it is not possible for the Board to give hearings in all sections of Canada as often as once in the course of a year. The demand for such hearings comes almost always from municipalities.

The part that the Board takes in the settlement of the various railway problems that confront the Dominion may be explained best by some brief comments upon its more important powers. In one very important particular the authority of the Board over construction is limited, for it cannot authorize the construction of any new lines except branches that are less than six miles in length. Railways in Canada can be built and operated only by specially chartered companies, and the promoters of every new railway project must secure the passage of a private bill through Parliament before they can legally take any steps towards the construction of the road. It is becoming more difficult from year to year to secure the passage of such bills, and it is not unknown for a bill to be so altered before its final passage as to fix such an unsatisfactory route for the lines, or to make the bonding powers of the company so limited that the project has been abandoned. The position taken by Parliament is that a railway is above all "a work for the general advantage of Canada," and that, therefore, it should not be planned solely for the private benefit of its promotors; and Parliament has seen fit to retain to itself the right to remodel any project into the form that it considers will be most satisfactory to the public. The Railway Act authorizes the Minister of Railways and Canals—not the Board of Railway Commissioners—to approve the route of a projected railroad whose charter has been granted, but in giving such approval the Minister holds himself to be governed by the exact wording of the special Act of Incorporation and by the discussion which took place and the representations which were made in the Committee meetings of the House. The clauses of the General Railway Act are made part of every special Act that is passed. The Board of Railway Commissioners, unless otherwise directed, is permitted to vary the route approved by the Minister to the extent of one mile, but this is the limit of its juris-

diction over the routes of new roads. The great battles between rival interests for the securing or protecting of territory must, therefore, be fought out in the House itself and not before the Board.

Perhaps the most noteworthy of the many powers vested in the Board is the right to authorize the expropriation of private lands for railway purposes without the owner's consent. Only those who have endeavored to build up a railway system in communities whose laws do not provide such powers can realize how vital they are to successful railway construction, and even those who have had lands taken from them which they would not willingly have sold at any price must appreciate the occasional necessity of sacrificing the wishes of the individual to the good of the community. The railway companies are required to file large-scale detail plans of their locations with the Board for approval after their route maps have been approved by the Minister, and this approval carries with it the right to expropriate by proper procedure the lands shewn by the plans to be required. The widths of the right of way that may be taken are clearly defined by the Act, and the Board will not authorize the expropriation of greater widths except on special application. There is, however, practically no limit to the area of which the Board can sanction the expropriation, if sufficient cause be shewn by the railway companies. The Board has established precedents for taking the lands of one railway company for the use of another, and of expropriating private lands necessary to the carrying out of railway construction, but not directly required for right of way. Cases do not frequently come up in which individuals endeavor to secure the alteration of a location by the Board in order that their properties shall not be affected, for it is realized that a private interest will not be permitted to hamper the progress of a semi-public undertaking; but there are a number of cases on record in which other railway companies or municipalities have actively opposed the approval of the location plans on the plea that a route less injurious to other important interests can be found. Railway extension is still desired in Canada to such an extent that opposition to the plans of a new company on the grounds of paralleling is given practically no consideration except during the passage of the special Act through Parliament. The awards, when properties are expropriated, are made by a specially selected Board of Arbitrators.

The Board may also fix the terms upon which one railway company will be authorized to use the lands, tracks and buildings of another company, but such terms are more commonly settled by private

agreement between the railway managements without the intervention of the Board. The Board has in several cases fixed the switching charges at commercial centres entered by two or more railways, and has ordered the construction of interchange tracks to facilitate local movement.

The plans for the crossing of any line of transportation by a railway or of any railway by another line of transportation, be it canal, power line, railway or road, must be approved by the Board. Canadian practice in the matter of crossings has not yet taken the form of a hard and sharply-defined policy. Conditions throughout the country vary very greatly, and one application may be in connection with a crossing of two new lines in an unopened and unsettled district, and the next may deal with one that is in the heart of a crowded and highly developed city. The practice of the Board is to deal with each case on its merits, ordering alterations of alignment in some cases, separation of grades in others, interlocking plants in still others, and not infrequently no special protective appliances other than those required by statute. The plans for the alteration of existing crossings to provide for increasing traffic must also be approved by the Board, and the costs of such works may be apportioned by the Board upon the parties benefited, the orders in such cases usually being the expression of a compromise arrived at by the interested parties under pressure from the Board. In the case of new lines, the full cost of all crossing works is borne by the new company as a matter of recognized practice.

All the construction detail of the railways which materially affects the safety and convenience of the public is subject to the approval of the Board, but otherwise there is no interference with the companies' construction plans. The railways of the Dominion as a whole are built to a fairly high standard because it has been the policy of the Government to subsidize liberally all lines for the opening of which there has been active public demand, and all companies which accept such assistance are compelled to build to specifications drawn up by the Department of Railways and Canals. The time is near at hand when a railway will be regarded and treated throughout the Dominion in much the same way as any other commercial enterprise, but up to the present every great railway project has been undertaken primarily for the settling up and knitting together of the country, and the money necessary for construction purposes has been obtained on the security of a Government guarantee or a bonus grant. The various powers of the Board in construction matters are sufficiently extensive

to justify the statement that within broad limits the actual cost of construction might be determined by the orders of the Board.

Of even greater importance to the railway world are the powers given to the Board for the settling of passenger and freight rates. These powers and the general policy of the Government with regard to rates cannot be summarized better than by direct quotation from the sections of the Act itself which deal with the regulation of freight rates, the clauses dealing with passenger traffic being very similar to those quoted.

"321. The tariffs of tolls for freight traffic shall be subject to and governed by that classification which the Board may prescribe or authorize, and the Board shall endeavor to have such classification uniform throughout Canada, as far as may be, having due regard to all proper interests.

"2. The Board may make any special regulations, terms and conditions in connection with such classification, and as to the carriage of any particular commodity, or commodities mentioned therein, as to it may seem expedient.

"3. The company may, from time to time, with the approval of the Board, and shall, when so directed by the Board, place any goods specified by the Board in any stated class, or remove them from any one class to any other higher or lower class; provided that no goods shall be removed from a lower to a higher class until such notice as the Board determines has been given in the *Canada Gazette*.

"4. Any freight classification in use in the United States may, subject to any order or direction of the Board, be used by the company with respect to traffic to and from the United States.

"322. All tariff by-laws and tariffs of tolls shall be in such form, size and style, and give such information, particulars and details, as the Board may, by regulation, or in any case, prescribe.

"323. The Board may disallow any tariff or any portion thereof which it considers to be unjust or unreasonable, or contrary to any of the provisions of this Act, and may require the company, within a prescribed time, to substitute a tariff satisfactory to the Board in lieu thereof, or may prescribe other tolls in lieu of the tolls so disallowed.

"2. The Board may designate the date at which any tariff shall come into force.

"3. Any tariff in force, except standard tariffs hereinbefore mentioned, may, subject to disallowance or change by the Board, be amended or supplemented by the company by tariffs in accordance with the provision of this Act.

"4. When any tariff has been amended or supplemented from time to time, the Board may order that a consolidation and reissue of such tariff be made by the company.

"325. The tariffs of tolls which the company shall be authorized to

issue under this Act for the carriage of goods between points on the railway shall be divided into three classes, namely,—

(a) The standard freight tariff;
(b) Special freight tariffs; and
(c) Competitive tariffs.

"326. The standard freight tariff, or tariffs, where the company is allowed by the Board more than one standard freight tariff, shall specify the maximum mileage tolls to be charged for each class of the freight classification for all distances covered by the company's railway.

"2. Such distances may be expressed in blocks or groups, and such blocks or groups may include relatively greater distances for longer than for shorter hauls.

"3. The special freight tariffs shall specify the toll or tolls, lower than in the standard freight tariff, to be charged by the company for any particular commodity, or commodities mentioned therein, as to it may classes of the freight classification, or to or from a certain point or points on the railway; and greater tolls shall not be charged therein for a shorter than for a longer distance over the same line in the same direction, if such shorter distance is included in the longer.

"4. The competitive tariffs shall specify the toll or tolls, lower than in the standard freight tariff, to be charged by the company for any class or classes of the freight classification, or for any commodity or commodities, to or from any specified point or points which the Board may deem to have declared to be competitive points not subject to the long or short haul clause under the provisions of this Act.

"327. Every standard freight tariff shall be filed with the Board, and shall be subject to the approval of the Board.

"2. Upon any such tariff being filed and approved by the Board the company shall publish the same, with a notice of such approval in such form as the Board directs in at least two consecutive weekly issues of the *Canada Gazette*.

"3. When the provisions of this section have been complied with, the tolls as specified in the standard freight tariff or tariffs, as the case may be, shall, except in the cases of special freight and competitive tariffs, be the only tolls which the company is authorized to charge for the carriage of goods.

"4. Until the provisions of this section have been complied with, no toll shall be charged by the company.

"328. Special freight tariffs shall be filed by the company with the Board, and every such tariff shall specify the date of the issue thereof and the date on which it is intended to take effect.

"2. When any such special freight tariff reduces any toll previously authorized to be charged under this Act the company shall file such tariff with the Board, and shall, for three days previous to the date on which such tariff is intended to take effect, deposit and keep on file in a convenient place, open for the inspection of the public during office hours, a copy of such tariff, at every station or office of the company where freight is received, or to which freight is to be carried

thereunder, and also to post up in a prominent place, at each such office or station, a notice in large type directing public attention to the place in such office or station where such tariff is to be kept on file: Provided that the Board may by regulation or otherwise determine and prescribe any other or additional method of publication of such tariff during the period aforesaid.

"3. When any such special freight tariff advances any toll previously authorized to be charged under this Act, the company shall in like manner file and publish such tariff ten days previously to the date on which said tariff is intended to take effect.

"4. Upon any such special freight tariff being so filed, the company shall, until such tariff is superseded, or is disallowed by the Board, charge the toll or tolls as specified therein; and such special freight tariff shall supersede any preceding tariff or tariffs, or any portion or portions thereof, so far as it advances or reduces the tolls therein.

"329. Competitive tariffs shall be filed by the company with the Board and every such tariff shall specify the date of the issue thereof, and the date on which it is intended to take effect: Provided that where it may be necessary to meet the exigencies of competition, or as the Board may deem expedient, the Board may make rules and regulations governing the filing and publication of such tariffs, and may provide that any such tariffs may be acted upon and put in operation immediately upon the issue thereof by the company, before they have been filed with the Board."

It will be noted that the powers of rate making as stated above are very wide and the shipping interests of the country have not been slow in making applications both for the readjustment of rates and for their actual reduction. The Canadian Manufacturers' Association, for example, has retained a trained railroad man as special adviser to its transportation committee, and has been well prepared to press its requests upon the consideration of the Board. Many orders have been issued specifically fixing the tariffs between various points for various commodities and the clauses of the Act which provide protection against discrimination in all its many forms have been freely invoked. As an extreme case it may be mentioned that the Board in the fall of 1905, at the time of the heavy grain movement and in the midst of a car famine, made an order, after application and hearing, specifying the proportion in which the available empty cars were to be distributed to the various grain ports on Georgian Bay.

Briefly, the policy that the Government has laid down and has entrusted to the Board to carry out is that all railway charges shall be fully known to the shipping public, that no discrimination either in favor of a locality or of individuals shall be permitted, that the

charges themselves shall not be unreasonably high, and that the machinery provided shall be such that the tariffs can be rapidly adjusted to the varying conditions of trade. No effort, however, is to be made to discriminate legally against a locality that is favored by nature for the benefit of one that is not so well situated, and the great waterways of Canada which in extent and possibilities are perhaps unequalled elsewhere on the face of the earth are recognized as a great factor in the determination of the cost of long-distance transportation.

It will be recognized from this statement of the more important duties with which the Board is charged, and the list is by no means exhaustive, that their successful discharge calls for moderation, good temper, plenty of thought, hard work and heavy travelling. The Commissioners have in fact been given no easy task. They have been appointed to compel the railway corporations to be just and reasonable in their dealings with the public, but it cannot be said that the public is always just and reasonable in its demands upon the corporations, nor can it be expected that there will not be endeavors to force the Board by popular outcry into positions unfavorable to the corporations. The public gives but little consideration to the ultimate result of the granting of its desires, and it is in the main entirely ignorant of the very narrow margins of profit upon which the railways are operated and of the amount of extra expenditures that must be made in order that those desires shall be satisfied. It is also prone to think that the particular difficulty in the matter of accommodation or service or equipment of which it complains is such a little item that no good management would permit it to remain uncorrected. It forgets that there are hundreds of other difficulties each awaiting its turn for consideration and settlement, and that the men whose duty it is to decide upon such matters are ever being pressed on the one hand by demands for better and more frequent service, better rolling stock, better roadbed and better terminals, and that they are on the other hand prevented by law from making those increases in charges which would in any other business immediately follow an increase of operating expenses or the provision of more liberal accommodation. The policy of the Board being to hold its hearings at the place where the complaint originates, the evidence laid before it is necessarily affected by local prejudice and narrow outlook, and it can be no easy matter to weigh correctly the dispassionate testimony of the railway representatives against such interested evidence, and its more vehement endorsation by the local press.

In justice to the fairness of the Board, it may be said that no at-

tempt has ever been made, to the writer's knowledge, to invest its decisions with a political character, and that the appeals taken against its orders have been few. It has, of course, had the advantage of working only in a period of great prosperity, during which the companies have been able to carry out orders which are sometimes considered to be too favorable to the public, without serious financial difficulty. There has been some comment by the members of the Board to the effect that the public is inclined to consider it as a commission for inquiry and not as a tribunal, and that there is a tendency to make very vague complaints with the expectation that the trained staff of the Board will be put to work to collect the necessary particulars, and to determine whether or not there is cause for complaint. In view of the breadth of the Commission's jurisdiction, and the immense territory over which it is called upon to work, it is evidently not reasonable that an appeal should be made to it except on the grounds of a very real grievance and accompanied by a very thoroughly prepared digest of the complaint.

In conclusion it may be said that the Board is to be regarded as an experiment in government, made by a rapidly growing country in an endeavor to provide that its railways shall be intelligently built with due regard to public safety and the general advantage, that they shall be properly equipped and efficiently operated, and that the charges for transportation shall be reasonable and free from all suspicion of manipulation in favor of private interests. The Railway Act, under which the Board exercises its authority, is a recent compilation and will be subjected to much amendment. The Board itself has been in active service for only a little over three years and its staff is not yet fully organized. It would be, therefore, entirely premature to express any opinion as to the ultimate success of this particular method of corporation control, and all that can be said at present is that the Board has so performed its duties that the Canadian people as a whole are entirely content that the experiment shall be continued.

A MUSEUM OF TRAFFIC AND ENGINEERING.

By Dr. Alfred Gradenwitz.

The value of permanent industrial exhibitions as a means of promoting technical education was ably argued by Mr. Alfred Sang in THE ENGINEERING MAGAZINE for October, 1906. In the following paper Dr. Gradenwitz describes one of the most important industrial museums in Germany, in which the exhibits are devoted principally to railroad engineering. —THE EDITORS.

THE Museum of Traffic and Engineering, *(Verkehrs- und Baumuseum)* recently inaugurated at Berlin is intended to contribute to a more general understanding of the present state of traffic and engineering, while facilitating investigations and improvements relative thereto. The exhibits accordingly comprise mainly modern plants, the historical part being confined to those subjects which are either of paramount importance, or indispensable for an understanding of present-day installations.

The museum is located in the old Hamburg Passenger Railway Station, the operation of which has been discontinued since the purchase of the Berlin-Hamburg Railway by the Prussian State. The station building, however, required thorough reconstruction, so far as its basement is concerned. The large courtyard between the building and the side wings was at the same time covered over with a three-aisle iron hall, extending along three axes beyond the side wings and thus ensuring a length of 71 metres and a width of 29 metres. This hall forms the main part of the exhibition, while a special railway and switching or shunting house, with its switching and signalling plants, was arranged outside.

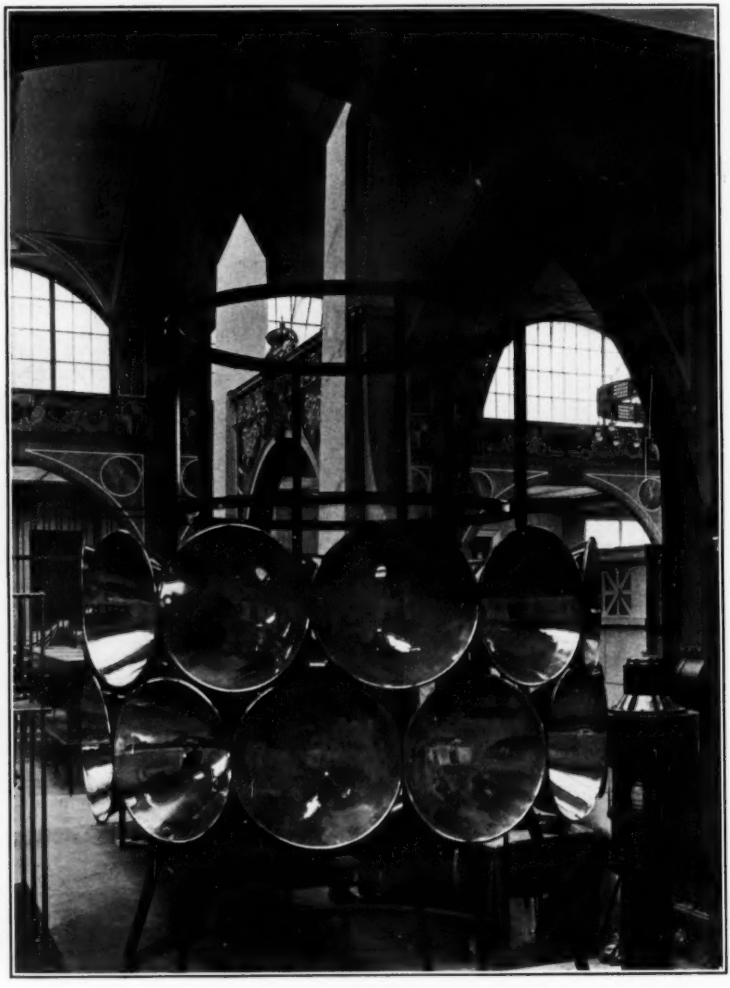
The rooms of the museum, (4,800 square metres in total area) are provided with central heating, and with a complete electric-lighting plant, allowing the exhibits to be studied and models to be demonstrated in the evening as well as by daylight.

The reconstruction necessary for adapting the ancient railway station to its present purpose was designed and carried out by Regierungsrat Schwartz, (to whose courtesy the writer is indebted for the particulars given in this article) and by Regierungsbaumeister Dörgé.

THE EXTERIOR OF THE MUSEUM.

The museum comprises three main departments, devoted to railway, naval, and civil engineering respectively. The exhibits belonging to related groups have been arranged in juxtaposition wherever possible. Explanatory notes are added to many exhibits, while in many cases a cross-section is given to illustrate the internal arrangement. Beside natural-size models there will be found many models on a reduced scale, especially of locomotives and signalling plants, which are operated either by hand, compressed air, or electricity. Whenever visitors are allowed to work the models themselves, the fact is mentioned by a special note. Models of plants of exceptional interest are to be demonstrated and explained from time to time by officials of the museum. Aside from rich stores of diagrams, photographs, and statistical tables, the institution comprises a reading room, in which outside of the trade papers of the day will be found a full library of rare and old books, thus allowing any part of railway and civil engineering to be most thoroughly investigated.

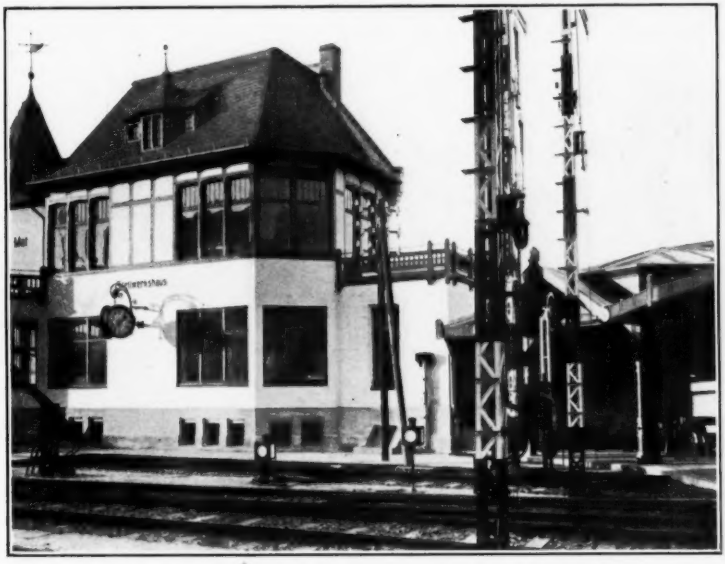
By far the greater part of the show rooms is occupied by the Railway Section, the exhibits of which are so comprehensive and numerous as to require a sub-division into several self-contained departments.



NAVAL ENGINEERING EXHIBIT.

Department A illustrates the evolution of railway tracks in all their parts, comprising rails, supports, sleepers, switches, and crossings, from the origin of railways till the present day. Samples of materials required for the upkeep and maintenance of the permanent way will likewise be found there. Sections of worn-out sleepers and

rails, removed from the tracks of very busy railway lines, will prove specially instructive for the study of the wear of these parts of the track, while the influence of the shocks exerted on the roadbed and material by running locomotives and wagons will be demonstrated by sample cases prepared in a special testing plant. The large variety obtaining in the road material is illustrated by a collection of various kind of broken stone used as rail ballast. Another collection comprises such tools as are used in laying and replacing rails and sleepers.



EXHIBITS OF SIGNALLING AND SAFETY DEVICES, RAILWAY TELEGRAPH AND TELEPHONE PLANTS.

Three plates hung upon the walls give a comprehensive view of the successive increases made since 1842 on the rails and sleepers of Prussian State railways in order to allow for the increasing requirements of heavier carriages and augmenting speeds.

A relief model illustrates any details such as safety barriers, fire-protection strips, draining ditches, etc., of road crossings. A few special models of road barriers on a larger scale will likewise be found on exhibition, while engineering diagrams and models of snow ploughs are other features of this department.

Department B comprises any civil-engineering work required in

connection with the construction of railways. In the center of the vestibule will be found a relief model of the railway station of Altona, the tracks of which are a model plant illustrating the principle of avoiding wherever possible any crossings of the rails at grade, in order to increase the safety and smoothness of operation. The construction of locomotive sheds, water towers, goods sheds, transfer stations and passenger stations, is demonstrated by a collection of models, diagrams, and pictures, the continual evolution in this branch of railway engineering being illustrated by a few models of early construction. Engineering diagrams covering all kinds of railway office buildings and sanitary installations for the welfare of railway employees will be likewise found here.

DEPARTMENT C. RAILWAY SIGNAL SYSTEMS.

Another interesting exhibit is the model of the first large iron bridge ever constructed in Germany, viz, the Vistula Bridge near Dirschau, completed in 1857. A number of diagrams and collections relating to railway bridges of ancient and modern construction will be found very instructive for the student of bridge building. The construction of tunnels is likewise explained by sketches and diagrams, while a model of the ventilating plant of the Kaiser Wilhelm tunnel near Cochem is likely to arouse special interest.

DEPARTMENT C. SWITCHING INSTALLATION.

Department C relates to railway-signalling and telegraph and telephone plants, comprising all such devices as have been designed for insuring the safety of operation on railways.

An electrically operated shunting plant, constructed by Messrs. Siemens & Halske, and two mechanical shunting plants, are exhibited

ready for operation in connection with a complete track, switches, and signals arranged outside the building. This plant was constructed on the lines of the highly praised "German railroad" exhibited at the St. Louis Fair, all its apparatus being typical of the latest type. A compressed-air switching plant with electrical control, as well as a number of block systems and shunting plants, either in originals or models, are exhibited in the main hall on a platform. On the gable wall there are installed, ready for operation, block systems, telegraph and telephone plants, and other arrangements used in the manager's room of railway stations, these apparatus being conveniently connected with the remaining parts of the plant, so as to afford a faithful illustration of their mutual relations.

Block systems for both single-track and double-track railways, and electrical alarms and track telephones exhibited in a condition ready for operation, fitly illustrate the signalling service of railway lines, the advance made in this connection being inferred from a comparison of early and recent devices.

The most extensive department is Department D, comprising railway locomotives and wagons, and which takes up nearly the whole of the main hall, in additon to two adjoining rooms. A comprehensive collection of models of locomotives and wagons to a scale of one-fifth natural size enables the construction of the usual types of rolling stock to be studied, both in historical development and present details. The greater part of the locomotive models were made by apprentices of the workshops of Prussian State railways. while several other models are gifts from locomotive works. These models are the more instructive, as they can be operated by compressed air. This collection comprises models of four and five axle bogey locomotives, compound and superheated-steam locomotives, toothed-wheel locomotives, the cab in an express locomotive, the smoke-box in a superheated steam locomotive, etc. The collection of models of wagons comprises both passenger and goods wagons, some types of the latter being especially interesting. A collection of models of railway compartments, both old and up-to-date, fitly illustrates the gradual advance made in the heating, lighting, and sleeping outfits of railway cars.

Among other interesting features of this section of the exhibition are two brake batteries, each of which consists of twenty brakes of the Carpenter and Westinghouse types respectively. The operation of the brakes in a train of twenty carriages is thus illustrated in a most instructive manner.

Among exhibits of historical interest should be mentioned an

DEPARTMENT C. SIGNAL SYSTEMS, RAILWAY TELEGRAPHY AND TELEPHONY.

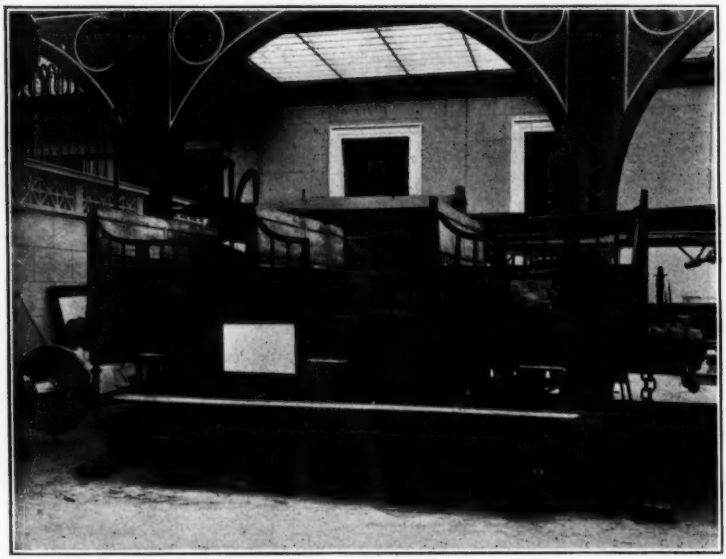
open passenger carriage of the ancient Breslau-Freiburg railway dating from the year 1843. These collections are supplemented by model diagrams.

Department E comprises high-tension electric plants for lighting, power-transmission, and railway operation.

Special interest attaches to the various parts of electric railways, including overhead lines, conductor shuntings, track insulators, track switch-outs, rail joints, controllers, driving motors, etc., which are mainly donations from the Allgemeine Elektricitätsgesellschaft and Siemens Schuckert Werke. This collection affords a practically comprehensive view of the development and present state of electric traction, at least in Germany. Only a few models of standard-gauge electric railway vehicles are however shown, of which the motor car used by the Siemens Company in connection with the famous Berlin-Zossen high-speed trials is most interesting. Another valuable exhibit is the first practical single-phase motor ever constructed for railway traction, which is designed on the Winter-Eichberg system. This motor was the first to demonstrate the possibility of operating trunk railways by high-tension alternate current from a single overhead wire. The model of a motor car of the Blankenese-Ohlsdorf Metropolitan and Suburban Railway (which is the first railway of this kind operated with single-phase current) will be installed shortly.

Department F is given up to the management of railway workshops and the mechanical equipment of railways.

While the Prussian Railway Department does not undertake to



OPEN PASSENGER CARRIAGE OF THE OLD BRESLAU-FREIBURG RAILWAY, 1843.
EXHIBITED IN DEPARTMENT C.

DEPARTMENT D. EXHIBITS OF ROLLING STOCK.

build any new vehicles, it runs extensive workshops for the up-keep and reconstruction of vehicles, its equipment comprising 15,368 locomotives, 28,723 passenger carriages and 320,198 luggage vans and goods wagons. Models of the main workshops of Opladen and Gleiwitz will be found to the left of the main hall. The operation of these workshops is illustrated by models of machine tools made to the scale of 1 to 5. Some of these machine tools are designed so that they can be operated. An interesting exhibit is a model of an attachment for quickly exchanging worn-out wheel sets in railway carriages. Other models comprise turn-tables and travelling platforms, as well as a Dowson gas plant, supplying the gas used in the lighting of railway cars.

Among other remarkable exhibits may be mentioned models of railway ferries, coal-wagon tilters, and an apparatus for exchanging the trucks of normal gauge to trucks of Russian gauge, and the mechanical ventilating plant for the Kaiser Wilhelm tunnel. Mechanical locomotive-coaling plants recently installed on German railway stations are likewise shown.

Railway management from a business point of view is covered by Department G, which in addition to all kinds of printed matter on railway traffic and management, comprises such devices as are used in

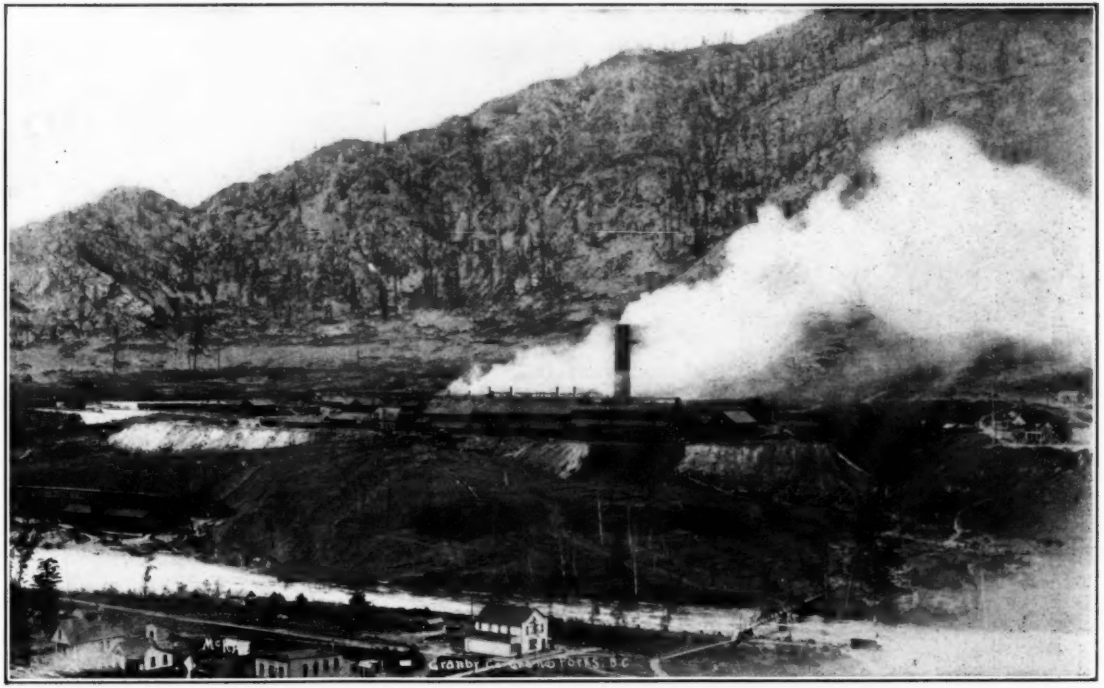
DEPARTMENT D. PARTS OF LOCOMOTIVES AND OTHER ROLLING STOCK.

the making up of trains, as well as signalling devices (connected with the shunting plant installed in Department C), and fully equipped ticket and luggage offices in addition to a station room electrically connected to the shunting plant, and from which the controlling of the railway and shunting service by a single official is demonstrated.

Department H comprises extensive collections of all kinds of documents, time-tables and official records, relative to the establishment, construction, and management of railways, as well as to the welfare of railway employees.

The collections installed in the eastern side wing and the adjoining section of the main hall are devoted to naval engineering, including river, canal, and marine construction. The most recent achievements of civil engineering—such as weirs, reservoir embankments, sluices, viaducts, as well as the improvement work on natural and artificial waterways, river and harbour plants, and the construction of dykes—are illustrated by a number of models, plans and pictures. The operation of light-houses is likewise covered by a collection of apparatus designed to be shown in full working order. Models of Heligoland, of the Königsberg sea channel, of the Swinemünde-Stettin waterway, with a self-contained, electrically operated lighting plant, as well as models of steamships, steam dredges, etc., should be especially mentioned. These collections are supplemented by a number of treatises and trade papers located in the special reading room.

The department devoted to civil engineering comprises recent construction by the civil-engineering department of the Prussian State, as well as a number of models of recent State buildings, and an extensive collection showing building materials and construction methods.



THE GRANBY SMELTER, GRAND FORKS, BRITISH COLUMBIA.

COPPER-SMELTING PRACTICE IN THE BOUNDARY DISTRICT, BRITISH COLUMBIA.

By Frederic Keffer.

THE Granby Consolidated Mining, Smelting and Power Co. was the first concern in the District to undertake the building of a smelter plant. Construction on its plant at Grand Forks was started in the summer of 1899, and by August of 1900 the first of the 300-ton furnaces was blown in, followed in October by the second. In the spring of 1902 two more furnaces built during the winter were blown in, and in January of the same year the converter plant, then the only one in the Boundary, was put in successful operation. In the early winter of 1903 two more furnaces were blown in, and in October of 1905 still another pair were added, thus making eight in all, and giving the plant a capacity of some 3,000 tons per day. This great plant has treated up to the first of June of the current year some 3,380,000 tons.

The British Columbia Copper Co. Ltd., began work on its smelter plant at Greenwood in the fall of 1899, shortly after the Granby Company had begun its work. The first furnace was blown in in February, 1901, and in 1902 a second 300-ton furnace was added to the plant. In the summer of 1904 the converter plant was started, the matte having previously been blown up to blister copper by outside plants. In 1906 it was decided to reconstruct and enlarge the plant on the most modern lines, and during that year the old furnaces were torn down and replaced by the present plant of three huge furnaces, the capacity of each furnace being 650 to 750 tons per day, making the whole a smelter of from 1950 to 2250 tons daily capacity. The first of these furnaces was blown in in October, 1906, and the last in the spring of the present year. Up to the first of June the British Columbia Copper Co. had smelted 1,110,000 tons of ore.

The original plant of the Dominion Copper Co., at Boundary Falls, was built in 1900 by parties whose idea was to do pyritic smelting. Inasmuch as the Boundary ores are very low in sulphur, it is needless to say that the plant proved a failure. After divers vicissitudes the plant finally passed into the hands of the Dominion Copper Co., which company rebuilt it to a great extent, adding to the two

furnaces then installed, a third huge furnace, the largest in the District. This furnace was recently blown in, and gives the smelter a capacity of from 1200 to 1400 tons per day. The smelter had treated 528,000 tons of ore up to June 1st.

As in other extensive mining districts, the ores of the Boundary include many diverse types, but for convenience they may be generally classified as follows:

GENERAL CLASSIFICATION OF BOUNDARY ORES.

- Ores.
  - Basic.
    - Magnetites:—
      - Fine grained massive as in the ..... — Mother Lode. Sunset. Emma.
      - Specular—As in the..... — Knob Hill. Old Ironsides.
    - Pyrrhotites:—Usually with some magnetite as in the..... — Mountain Rose. Napoleon. Senator. Morrison.
    - Garnetites:—As in the Oro Denoro mines.
    - Calcites:—As in the Mother Lode.
    - Pyrites:—As in the Mother Lode and many other mines.
  - Acid.
    - Highly silicious altered lime products occurring in most of the Boundary mines.
    - Quartz with ores of copper disseminated through talcose schists, as in the Lone Star.
    - Quartz with galena, zinc blende and pyrite as in the..... — Providence. No. 7.
    - (These are narrow veins with high values in gold and silver.) — Skylark, and several other mines.
    - Quartz with much arsenical pyrites, as in the Athelstan.
  - Neutral.
    - Altered volcanic ash, tufa, etc., impregnated with copper minerals as in most of the mines in Phoenix, for example the..... — Knob Hill. Old Ironsides. Snowshoe. Rawhide. Gold Drop. Monarch and many other mines.
    - Altered eruptive rocks occurring near limestone contacts, and generally associated with dykes of porphyry, as in the..... — Mother Lode. The "B. C." Jumbo.

It will be seen from the table that although the Boundary ores are generally spoken of as "self-fluxing" there is, nevertheless, a wide range in the composition of ores from different mines in the District. The neutral ores, however, constitute a decided majority of the whole, and by suitably combining the others, neutral mixtures may be had without addition of barren flux, which fact, in effect at least, bears out the Boundary's claims as to its self-fluxing ores. Partial analyses of the different classes of ores are given on the opposite page:—

PARTIAL ANALYSES OF TYPICAL BOUNDARY ORES.

		Silica, Per cent.	Iron, Per cent.	Lime, Per cent.	Sulphur, Per cent.
Basic Types.	Emma Mine	12.60	46.10	11.30	1.00
	Napoleon Mine	16.60	43.20	2.50	24.80
	Mountain Rose Mine...	11.80	38.60	9.80	24.70
	Oro Denoro Mine.....	29.10	22.10	22.90	1.75
Acid Types.	Lone Star Mine.....	49.80	8.82	2.30	7.58
	Providence Mine	88.60	2.50	2.60	1.80
	Ben Hur Mine.....	76.80	1.90	9.80	.00
	Athelstan Mine	40.00	14.80	1.10	....
Neutral Types.	Mother Lode Mine.....	32.26	16.41	20.27	2.92
	Snowshoe Mine	34.30	12.86	18.43	2.56

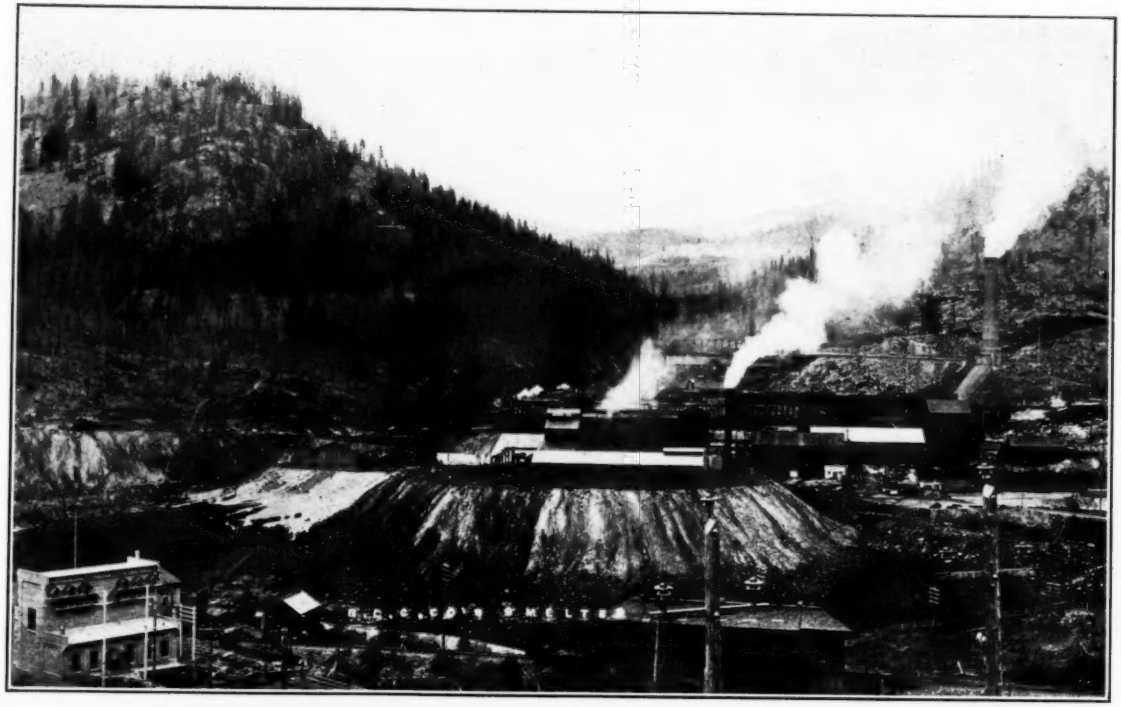
In these ores alumina will range from nothing to 15 per cent., the average being about 8 per cent. The following complete analysis of a sample of Mother Lode ore gives the percentages of the various constituents together with the manner in which they probably exist in the ore.

COMPLETE ANALYSIS OF MOTHER LODE ORE, FROM UPPER WORKINGS.

			Per cent.
Silica ..... SiO_2	Combined as Silicate		36.18
Alumina ..... Al_2O_3	" "		10.16
Lime ..... CaO	" as Carbonate		9.34
Total, 18.81 per cent.	" as Silicate		9.47
Magnesia ..... MgO	" "		2.59
Potash ..... K_2O	" "		.25
Soda ..... Na_2O	" "		.32
Carbonic Oxide.... CO_2	" as Carbonate of Lime....		7.34
Copper ..... Cu	" as Chalcopyrite		1.94
	" "		1.71
Iron ..... Fe	" as Pyrite, FeS_2		1.91
Total, 14.36 per cent.	" as Ferrous Oxide, FeO..		10.74
Sulphur ..... S	" as Chalcopyrite		1.95
Total, 4.13 per cent.	" as Pyrite		2.12
Oxygen ..... O	" as Ferrous Oxide, FeO..		3.06
Water ..... H_2O	" as Combined Water		.65
Total, 1.11 per cent.	" as Moisture		.46
	Total		100.25

Most of the Boundary ores contain lime as crystalline calcite, which mineral when heated in the furnaces tends to break up the whole mass speedily. Chiefly for this reason coarse crushing (from 4 to 6 inch size) suffices, a small saving in costs being thus effected.

Probably nowhere else in the world are copper ores containing sometimes as low as one per cent. of copper successfully smelted without any previous sorting or concentration. The Boundary ores run from 1 to 3 per cent. in copper, the average being not far from 1½ per cent. and from $1 to $3 per ton in gold and silver. It has been proved that ores containing 1.2 to 1.5 per cent. of copper will produce sufficient matte fall to collect the precious metals with but slight loss of these metals in the slag, and also sufficient to keep the furnaces in



THE BRITISH COLUMBIA COPPER COMPANY'S SMELTER, GREENWOOD.

good running condition. With 1 per cent. copper or less, the operation of the furnaces becomes exceedingly difficult as well as unprofitable. It is essential that there be enough sulphur in the ores to keep the matte within proper limits as to grade, a good average for matte being about 45 per cent. copper. Matte much richer than 50 per cent. copper occasions undue waste in slags, while matte running below 40 per cent. requires too much time for converting as well as too frequent renewals of converter linings. With the matte within bounds and with normal ores the slag losses in copper and precious metals can be kept within the limits of

Copper	.30 to .35	per cent.
Gold	.004 to .006	ounces
Silver	.04 to .06	"

per ton of slag. As the slag is about 85 to 90 per cent. of the charge, the loss per ton of ore is 85 to 90 per cent. of the above figures.

The following table shows in a general way the relations of copper, sulphur, and iron in varying grades of matte, this on the assumption that the matte is composed solely of these elements, which assumption is practically correct so far as this district is concerned.

COMPOSITION OF MATTES CONTAINING VARIOUS AMOUNTS OF COPPER.

Copper, Per cent.	Iron, Per cent.	Sulphur, Per cent.
40	31.8	28.2
42	29.5	28.5
44	28.1	27.9
46	26.4	27.6
48	25.2	26.8
50	23.9	26.1
52	21.4	26.6
54	20.4	25.6
56	19.2	24.8
58	17.2	24.8
60	15.3	24.7

From the above table it is seen that the sulphur required to form a 45 to 55 per cent. matte is about 25 per cent., or half as much sulphur as copper, so that an ore carrying 1.5 per cent. copper will require .75 per cent. sulphur. This, however, represents but a small part of the sulphur necessary in the charge, as by far the greater part is volatilized or burned to SO_2. In the Boundary a sulphur content of 5 to 6 per cent. is found requisite for good work. The ores mined by the Granby Company have as a rule sufficient sulphur for the matte, but the British Columbia Copper Co., and the Dominion Copper Co. supplement their sulphur with ores from their pyrrhotite mines, the Napoleon and Mountain Rose respectively.

The slags to work well must be neither so silicious as to be sticky, nor so basic with iron as to be too dense, as in neither case does the matte separate well from the slags. The following is the average composition of many thousand tons of slags made at the British Columbia Copper Co.'s smelter, which have been found satisfactory:

	Per cent.
Silica	39.77
Iron	20.62
Lime	22.11

The following is a complete analysis of an average of ten weeks' run of slag, taken at a period when the ores were a trifle more silicous.

	Per cent.
Silica	41.53
Iron (as silicate)	20.88
Magnesia	2.46
Lime	18.24
Alumina	9.10
Potash	.35
Soda	.46
Oxygen (with iron as FeO)	5.97
Copper (as matte mechanically mixed)	.37
Iron " " " "	.20
Sulphur " " " "	.17
Moisture	.15
Total	99.88

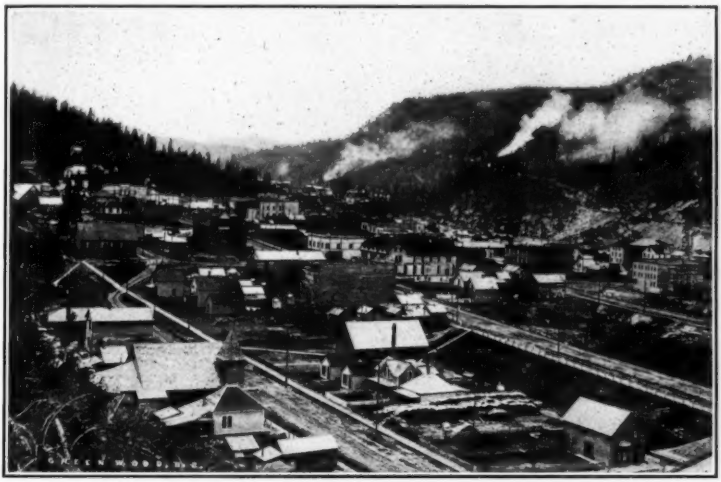
In the earlier history of the camp the tendency was toward more basic slags owing to the circumstance that in those days the ore mined was more basic than at present. The following analyses illustrate this point, being those of slags taken over considerable periods in the years named:

	Silica, Per cent.	Iron, Per cent.	Lime, Per cent.
1901	33.2	28.5	20.6
1902	40.5	22.2	20.2
1903	42.7	20.4	20.2
1904	43.3	22.0	16.3
1907	39.7	20.6	22.1

Latterly the ores have grown more basic, and the 1907 slags closely approximate those of 1902 in relative proportions of acid and base.

The amount of coke used is that which is just sufficient to properly fuse the charge, excess over this not only being wasteful, but also tending to reduce iron from the ore, at once robbing the mattes and building up troublesome "sows" in the hearths of the furnaces. It has been found possible to obviate the formation of sows entirely by regulating closely the amount of fuel used. The per cent. of coke varies between 12 and 13, the coke coming from the mines of the Crows Nest Pass.

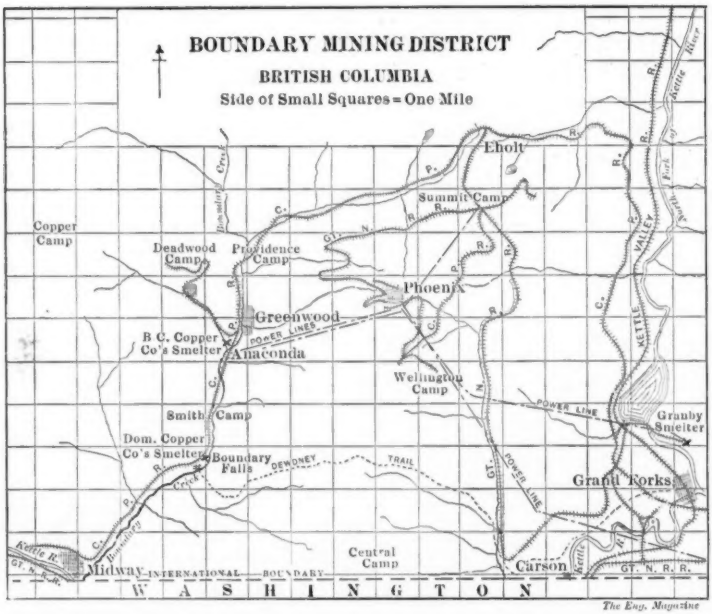
Foaming in the furnaces and settlers is occasionally troublesome, and appears to arise through the crystallization of magnetite (Fe_3O_4) from the fused mass of slag and matte. This mineral if heated beyond a certain point gives up an atom of oxygen, which, reacting on the matte, forms sulphurous acid gas, the bubbling of which interferes with the proper settling of the matte. The presence of sufficient sulphur in the charge and proper feeding usually prevent this trouble.



GENERAL VIEW OF GREENWOOD. THE BRITISH COLUMBIA COPPER COMPANY'S SMELTER IS IN THE DISTANCE.

The pressure of blast in the large furnace is 20 to 22 ounces per square inch, and in the smaller furnaces, 16 to 18 ounces. The amount of flue dust varies from 1 to 2 per cent. according to the season, the least forming with wet or frozen ores. The dust assays considerably higher than the ores from which it is derived, owing to the tendency of the softer chalcopyrite to break up. The dust is briquetted as fast as formed and returned to the furnaces. Fresh dust requires little or no lime as a binder, there being enough lime formed when the dust is in the furnace to bind the briquettes. Old dust usually requires some lime.

To describe in detail each of the smelters in the district would take more space than the limits of this paper will allow. The most recent of the plants, that of the British Columbia Copper Co. Ltd. at Greenwood, will therefore be taken as representatives of all the plants, embodying as it does the latest practice as developed in the Boundary. The elimination of labor was a cardinal point kept in mind when this



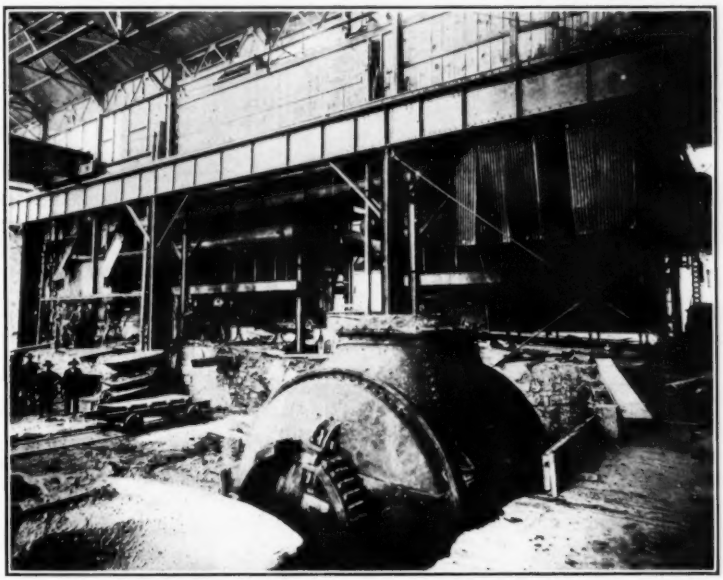
plant was designed, and this has been so successfully carried out that at present some 2000 tons are being smelted daily with a force aggregating about 135 men in the 24 hours.

Ores from the company's own mines are sampled by taking every tenth car, the uniformity of the ores permitting this to be done, thus saving time and expense. As all the ores are crushed at the mines, it is only needful to dump the unsampled ores directly in the bins whence it goes to the furnaces. Custom ores have, of course, to be sampled more carefully by passing the whole lots through the mill. Checks, based upon the extraction obtained and slag assays, are made at the end of each month, and it is found that the results obtained in this absolute manner agree very closely with the results obtained by sampling every tenth carload at the mill. In sampling, the ore passes through a series of four Johnson samplers, following Gates crushers and rolls, the final sample constituting about one-sixth of one per cent. of the original ore. The sample which, at this stage, is the size of wheat grains, is further quartered, bucked-down and passed through 80 or 100 mesh sieves in the usual manner.

From the sample-mill bins the ore goes over a conveyor belt to railway cars which take it to the main smelter bins. The latter bins

have a capacity of 12,000 tons of ore and 2,000 tons of coke. The ore next passes through chutes into the charge cars, which run six to a train, drawn by an electric locomotive. The loaded train passes over charge scales where the weight of each charge is brought to 5,000 pounds by additions from small piles of the same ore at the scales, or by removal of excess weight, as the case may be. The coke is similarly weighed into charge cars. The train then passes to the furnaces into any one of which the charge is dumped as desired. The furnaces are placed end to end, so that the charging tracks traverse the feed floor on each side of each furnace, thus allowing the charge to be fed in at any point. Baffle plates are hung inside the furnace to distribute the charge, and obviate the tendency of the fines to collect in a heap at the centre with the coarse ore rolling down the heap to the sides of the furnaces. This seemingly trifling point is of the utmost importance in the proper operation of the furnaces, as otherwise the matter is too high grade owing to the burning away of too much sulphur.

At the Granby works the charge cars are run directly into the furnace at the end, and the charge dropped through the bottoms of the cars. This plan distributes the ore and coke well, and produces good results. The system of side-dumping cars employed at Green-



THE THREE 20-FOOT BY 4-FOOT FURNACES OF THE BRITISH COLUMBIA COPPER COMPANY'S GREENWOOD SMELTER.

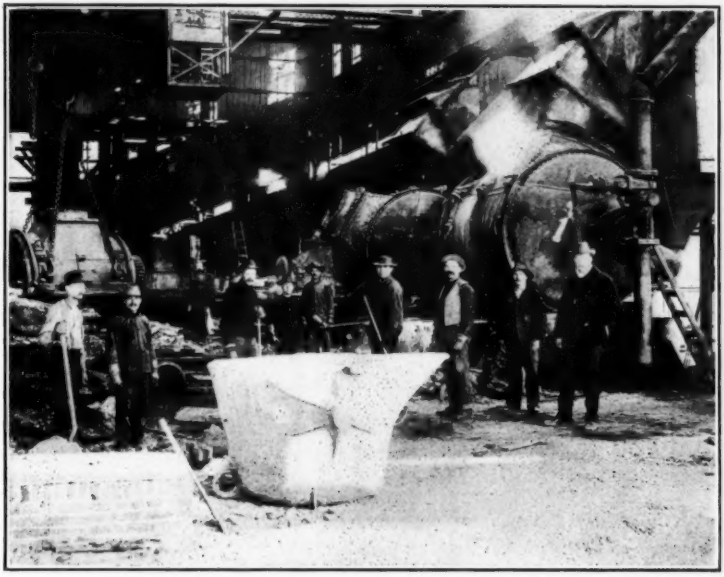
wood involves less switching of cars, and reduces track complications. The Greenwood furnaces are 48 by 240 inches at the tuyeres, and have a hearth area of 80 square feet. As the furnaces average some 650 to 750 tons each per day, the tons smelted per square foot of hearth area are 8.1 to 9.4 per day. There are 6 jackets and 24 tuyeres on each side of each furnace, the water jacketing extending all the way to the feed floor, thus reducing brick repair work to a minimum.

DUMPING MOLTEN SLAG, GREENWOOD SMELTER OF THE BRITISH COLUMBIA COPPER COMPANY.

Between the furnaces on the tapping floor, and at each end of the row, are oval settlers (4 in all) each being 4 feet 6 inches deep, and having diameters of 18 feet lengthwise and 10 feet 6 inches across. These huge settlers are lined with chrome fire brick, and are cooled externally by jets of water running down the steel sides. It will be seen that each furnace is thus served by two settlers, admitting of repairs to either without interfering with the work. The settlers at the other plants are much smaller, are water jacketed, and are arranged in pairs or sometimes in sets of three in order to secure good separation of matte from slag. With these large settlers the separation is good when but the one is used.

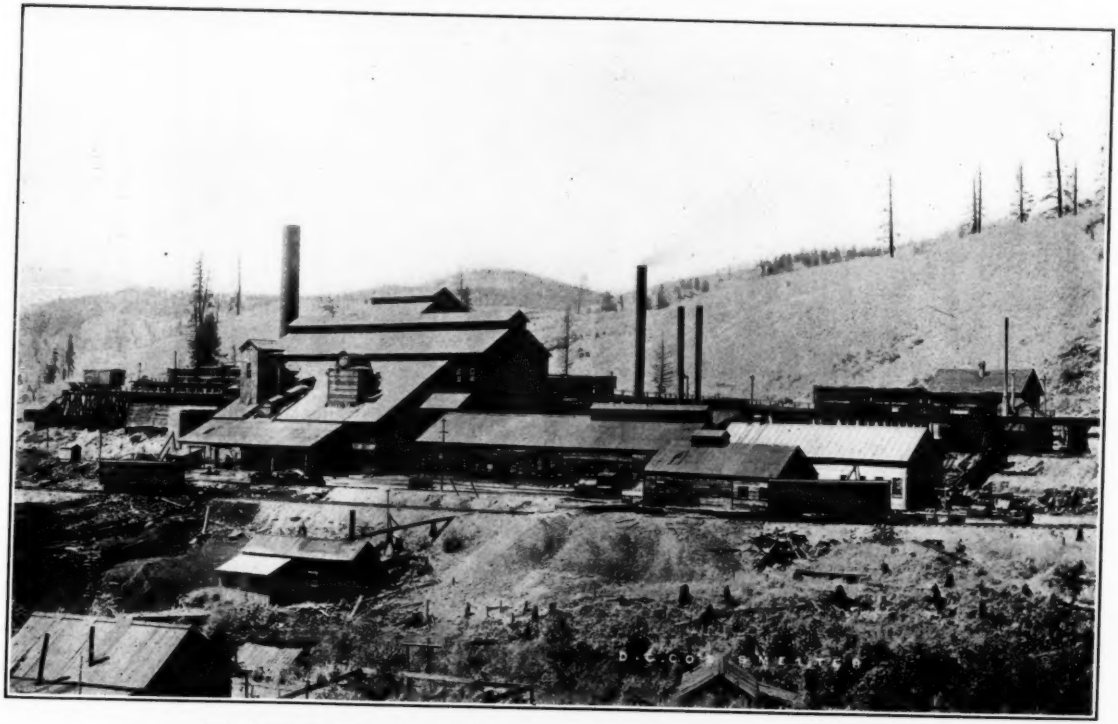
Slag from the settlers runs into slag cars of a capacity of 25 tons each and fitted with an electric dumping device and air brakes. Elec-

tric locomotives draw the cars to the dumps. While a full car is being replaced by an empty one the slag is caught in a ladle mounted on a pillar, which pours its load into the empty car when the latter is placed in position. In the early days of smelting in the Boundary, all the plants granulated their slags, but this practice has everywhere given place to carrying off the molten slag in cars. The slag cars run in a pit on the opposite side of the furnaces from the converter room, and are thus out of the way of other operations.



CONVERTER ROOM, BRITISH COLUMBIA COPPER COMPANY'S SMELTER.

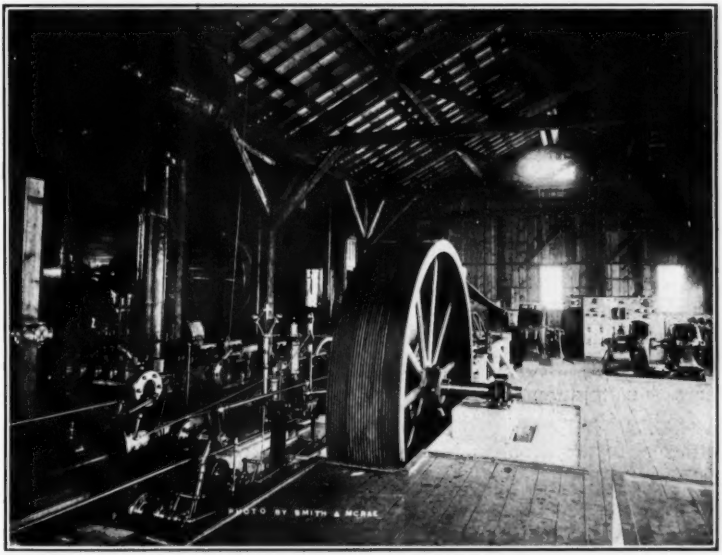
On the converter side of the furnaces, matte is tapped into large ladles and carried by a 40-ton electric crane to the converter. There are two converter stands, and the moment one charge is finished, and while it is being poured off, the other converter is started with a new charge of matte, thus preventing loss of time. Each charge produces from 15 to 30 ingots of blister copper of average weight of 300 pounds, the larger number of bars coming from the last charges when the lining of the shell has been largely fluxed away. The linings are of clay and gold quartz crushed and mixed in a Carlin mill, and are tamped into the converter shells with pneumatic tampers. Each lining will run 3 or 4 charges before being used up. The blister copper produced is exceptionally free from arsenic or other objectionable impurities and runs 99 per cent. fine. Great care is taken to prevent loss of



THE DOMINION COPPER COMPANY'S SMELTER, BOUNDARY FALLS, BRITISH COLUMBIA.

converter flue dust, the flue passing through a large brick settling chamber, in which the gases deposit any dust not caught in the flues. Converter flue dust runs from 65 to 75 per cent. copper, and is recharged into the converters with fresh matte.

The power plant consists of three Roots rotary blowers, each delivering 300 cubic feet of air per revolution, driven by 300 horse-power electric motors. A Nordberg blowing engine, capacity 5000 cubic feet of air per minute and driven by a 300 horse-power motor supplies air to the converters. Two motor generators furnish direct current to the crane and trolley lines, and there are, besides these, electrically driven pumps, air compressor, etc. The entire plant is operated by electric power from Bonnington Falls 80 miles distant.



CONVERTER POWER HOUSE, BRITISH COLUMBIA COPPER COMPANY'S SMELTER.

The new furnace at the Dominion Copper Co.'s plant at Boundary Falls, is the largest in the Province, its dimensions being 48 by 256 inches at the tuyeres. It has also an innovation in the shape of a Giroux hot blast, whereby the blast is heated in pipes arranged about the brick stack above the feed floor. This furnace has been in operation only a few weeks, and is regarded with much interest by those engaged in the industry in the district, but it has not been in blast a sufficient length of time to say whether the hot blast will effect any material saving in fuel, or will increase the capacity of the furnace.

THE OPERATING COSTS AND REVENUE OF URBAN RAILWAYS.

AN ANALYSIS OF THE INTERBOROUGH SYSTEM OF NEW YORK CITY.

By Gerard B. Werner.

This analysis of the last annual report of the Interborough Rapid Transit Company serves a two-fold purpose: it offers an interesting review, on the unit basis, of the operating costs of one of the largest and most involved systems of urban rapid transit in the world, and its comparison of gross and net income shows clearly the enormous inroads on the revenue made by fixed charges in this type of electric-railroad operation. Taken in connection with Mr. Werner's paper in THE ENGINEERING MAGAZINE for March, 1907, the information presented cannot fail to be of value in solving problems of electrification on steam railroads, and its consideration of profits will remove much of the popular misapprehension as to the dividend-earning power of this type of public utility.—THE EDITORS.

THE elevated and subway systems of the city of New York offer a representative example of heavy electric traction in large cities. The earnings and expenses of the particular operating company are of course influenced by factors which for the most part are peculiar to the locality. Geographical conditions and the size of the tributary population, among other things, govern the number of passengers carried; and the engineering layout of the power equipment, the efficiency of the management, and especially the fixed charges, affect the cost of carrying the passenger. It is therefore hazardous to attempt to deduce any general laws on this subject from a study of any one system of transit lines. But a peculiar interest attaches to the problem in New York on account of the enormous traffic which this public utility handles, and on account of the size and efficiency of the power stations which supply the motive power. It is with this idea in mind that I have attempted an analysis, on the unit basis, of the report of the Interborough Rapid Transit Company for the year ending June 30, 1906, recently published by the New York State Board of Railroad Commissioners in their annual report.

CHARACTERISTICS OF SYSTEM AND EQUIPMENT.

The Elevated and Subway roads in New York are rather too well-known to warrant any detailed description. A few items, therefore, of the extent and equipment of each are given, which may serve as a basis of reference.

TABLE I. EXTENT AND EQUIPMENT OF LINES.

	Elevated Division.	Subway Division.	Total.
Length of road, miles	37.68	21.79	59.47
Length of single track,* miles	118.05	71.40	189.45
Number of generating stations	1	1	2
Capacity of " " "	45,500 K.W.	48,750 K.W.	94,250 K.W.
Number of sub-stations	7	8	15
Capacity of "	61,500 K.W.	64,500 K.W.	126,000 K.W.
Number of passenger cars	1,524	794	2,318
Number of employees	5,476	2,746	8,222
Passenger stations	199	97	296

* Including sidings and turnouts.

The rolling stock of the Subway consists of both wood and all-steel cars, 51 feet in length, seating 52 passengers. The motor cars of 200 horse-power nominal capacity weigh about 38.3 tons, and the trailers about 25.5 tons.

Traffic.

Of the 820,000,000 passengers carried by all the public transportation lines in the Boroughs of Manhattan and the Bronx during the year ending June 30, 1906, about one-half were handled by the elevated and subway systems. Table II shows the magnitude of the traffic on each of the latter.

TABLE II. TOTAL AND UNIT TRAFFIC.

	Per Year.
Revenue passengers, total	395,716,386
" " elevated	257,796,754
" " subway	137,919,632
Car mileage, total	93,654,185
" " elevated	61,723,112
" " subway	31,931,073
Revenue passengers, per car mile, total	4.23
" " " " " elevated	4.18
" " " " " subway	4.33
Car miles per mile of road, total	1,573,000
" " " " " elevated	1,635,000
" " " " " subway	1,462,000
" " " " of track, total	493,000
" " " " " elevated	523,000
" " " " " subway	447,000
Population, Manhattan and the Bronx	2,500,000
Rides per capita, total	158
" " " elevated	103
" " " subway	55

It will be seen that the passenger density is slightly greater in the Subway, due to the greater volume of travel on that line and perhaps to the fact that the cars are several feet longer than the Manhattan cars. On the other hand, the traffic density per mile is greater on the

Elevated—a fact which may be accounted for through the necessity of running both locals and expresses on the latter over the same tracks for a considerable portion of the runs.

The traffic of the Manhattan Division is handled by multiple-unit trains varying from three to seven cars, while that of the Subway division is taken care of by five- to eight-car trains. The number of motor cars average about 60 per cent of the train composition.

With the average degree of traffic density indicated above, some idea can be formed of the density during the rush hours. During those periods, the Second and Third Avenue trains run on about a 90-second headway; and the Subway trains, express and local, on about a 2-minute headway.

The schedule speeds attained on the various lines vary widely according to the character of the service. The Subway express and local trains approximate 25 and 15 miles per hour, respectively.

Operating Expenses.

It was deemed most suitable for the purposes of the present study to reduce the various items of the annual operating expense account to the car-mile basis, as in this form the figures are more significant than in the total amounts, and offer a more direct basis of comparison.

The account on the opposite page follows pretty closely the form adopted by the Street Railway Accountants' Association of America, and the details chargeable to each item may be found in the Association's report for the year 1905.

The maintenance of track and roadway, in the present instance, seems rather large, amounting as it does to $4,120 per mile of track. But it must be remembered that this item includes the maintenance of the structure, third rail, and interlocking and signal systems, and probably includes betterments or renewals. Of this amount, about $50 may be due to track bonding; about $400 to the working conductor; and the balance to the rails, ties, and structure.

The maintenance of buildings and fixtures includes the power-plant and sub-station buildings.

The total amount for way and structures of 0.996 cents per car mile is 11.10 per cent of the total operating expenses, as compared with an average of 0.98 cents for surface roads with overhead construction.

The maintenance of steam plant takes into account only the mechanical end of the generating stations, such as coal-handling apparatus, boilers, stokers, economizers, heaters, mechanical-draft apparatus, piping, engines, condensers, etc.

TABLE III. OPERATING EXPENSES.

Maintenance of Way and Structures.

	Cents per car-mile.
Maintenance of track and roadway	0.835
" " buildings and fixtures	0.161
	0.996

Maintenance of Equipment.

Maintenance of steam plant	0.126
" " electric plant	0.071
" " cars	0.487
" " electric equipment of cars	0.316
" " miscellaneous equipment	0.001
Miscellaneous shop expenses	0.213
	1.214

Operation of Power Plant.

Power-plant wages	0.513
Fuel for power	1.193
Water for power	0.136
Lubricants and waste	0.039
Running expenses of locomotive	0.008
Miscellaneous supplies and expenses	0.076
	1.965

Operation of Cars.

Superintendence of transportation	0.054
Wages of conductors and guards	1.397
" " motormen	0.631
" " miscellaneous car-service employees	0.376
" " station employees	0.907
Car-service supplies	0.056
Miscellaneous car-service expenses	0.248
Station expenses	0.131
	3.800

General.

Salaries of general officers and clerks	0.2570
Printing and stationery	0.0184
Miscellaneous office expenses	0.0381
" general "	0.0684
Damages	0.2920
Miscellaneous legal expenses	0.2520
Insurance	0.0712
	0.9971

Recapitulation.

	Cents per car-mile.	Per cent of operating expenses.	Per cent of gross earnings.
Maintenance of way and structures	0.996	11.10	4.73
" " equipment	1.214	13.54	5.78
Operation of power plant	1.965	21.90	9.36
" " cars	3.800	42.35	18.08
General	0.997	11.11	4.74
Total	8.972	100.00	42.69

The maintenance of electric plant comprehends, besides the electrical end of the generating stations, the sub-station apparatus and the cable work.

The maintenance of cars (the largest item in the maintenance of equipment), 0.487 cents per car mile, amounts to about $196 per car per year.

The maintenance of the electric equipment of cars, including motors, control, heaters and lights, of 0.316 cents per car mile, is $223 per motor car per year. This car-mile cost is low compared to other urban and interurban roads, where this figure reaches 0.7 and 0.8, and averages about 0.60. But the car-year cost is high probably on account of the multiple-unit control and large motors, among other influences. For hand-controlled cars of lighter motor capacity, the car-year maintenance averages about one-half, or $110.

The total amount for maintenance of equipment, of 1.214 cents per car-mile, compares favorably with other electric roads which give an average of 1.50 cents, reaching a maximum of 1.9 cents.

The item power-plant wages includes, besides the labor employed in the generating stations, the labor of the sub-station attendants. Similarly, lubricants, waste and supplies cover the requirements of the sub-stations, so that with the present data there is no means of segregating the proper amount to the generating stations alone.

The item fuel for power, which forms 61 per cent of the total power-plant operation offers a fruitful topic of reflection on what are probably the most efficient power plants extant. Mr. H. G. Stott, superintendent of motive power, has shown* that the thermal efficiency of the Interborough plant is 10.3 per cent, with coal of 14,150 B. T. U. per pound. One kilowatt hour, or 3,412 B. T. U. at the bus-bars, therefore, represents 33,100 B. T. U., or 2.34 pounds at the coal pile. Then, if it is remembered that this coal costs in the neighborhood of $3.00** per ton, the real significance of the coal bill will be appreciated. Using these figures on the plant economy and cost of coal, the total kilowatt hours generated during the year is then about 320,000,000. The cost of coal per kilowatt hour, therefore, works out to be 0.349 cents. This may be compared with the cost of fuel of 0.55*** cents per kilowatt hour at the power stations of the Boston Elevated, where coal costs $3.60 per ton.

The total cost of operation of power plant, 1.965 cents per car mile, is correspondingly low, since this item averages about 2.3

* Trans. Am. Inst. Elec. Engrs., Jan. 1906.
** Trans. Am. Inst. Elec. Engrs., Jan., 1907.
*** St. Ry. Journ., Sept. 30, 1905.

cents, with a maximum of about 3.0 cents in smaller and less efficient plants operating under similar conditions. Mr. L. B. Stillwell* is responsible for the statement that "the works-cost of a kilowatt-hour at the bus-bars of the Manhattan plant is less than 0.6 cent" including "fuel, water, labor, maintenance, miscellaneous supplies."

The operation of cars is predominantly a labor charge, and appears surprisingly low when one considers the great number of train men and station employees. This item, 3.800 cents per car mile, may be compared to the corresponding item for a number of typical electric railways which average 5.9 cents per car mile. The operation of the cars in multiple-unit trains contributes to the reduction of the expenses by minimizing the number of motormen required.

The general expenses afford no point of special interest. In passing, it may be remarked that the items under this head are, according to the accounting of the Interstate Commerce Commission, expenditures assignable to fixed charges.

The total operating expense per car mile of 8.97 cents is very low, and illustrates the performance which is attainable with a large and efficient engineering layout and a vigilant management. The operating cost on a number of representative electric roads, elevated and surface, averages about 13.0 cents per car mile, the higher figures representing urban lines. The Brooklyn Heights Railroad (elevated and surface) and the New York City Railway (surface)—to take two specific cases—run up to 14.8 cents and 18.4 cents, respectively.

The operating ratio of 42.69 per cent of the Interborough is correspondingly excellent, compared to the general average which may be expected on transit utilities of about 65 per cent. Last year's operation on the Brooklyn Heights showed a ratio of 55.81 per cent and the New York City, 54.96 per cent.

Fixed Charges.

Although the several items under General Expenses might be properly termed fixed charges, the general form of electric-railroad report classifies them under the operating account, and not as a deduction from the gross income.

TABLE IV. FIXED CHARGES.

Interest	0.381	cents per car-mile
Rentals	7.575	" " "
Taxes	1.485	" " "
	9.441	cents per car-mile

* Trans. Am. Inst. Elec. Engrs., Jan., 1907.

It will be noted that although the interest (on the funded debt) and the taxes (on operating property, structures, earnings and capital stock) are relatively small, the rentals (of leased lines) amount to 85 per cent of the operating expenses. The latter item includes $5,683,680.00 paid to the Manhattan Railway Co., of which $1,809,680.00 appears as interest on the funded debt of that company, and $1,410,476.19 paid to the City of New York as the interest on the city bonds issued for the construction of the Subway.

Income Account.

The abridged income account has been calculated on the car-mile and passenger basis (Table V). As it is practically a *résumé* of the matter which has already been presented in these pages, a few concluding observations may not be impertinent at this juncture.

TABLE V. INCOME ACCOUNT.

	Cents per car-mile.	Cents per passenger.
Gross earnings from operation	21.03	4.98
Less operating expenses (exclusive of taxes)	8.97	2.13
Net earnings from operation	12.06	2.85
Income from other sources *	0.77	.18
Gross income from all sources	12.83	3.03
Deductions from income	9.44	2.23
Net income from all sources	3.39	.80
Dividends	3.09	.73
Surplus	0.30	.07

Conclusion.

Of course, one must be intimately conversant with all conditions to judge properly the financial performance of electric properties. But a number of conclusions are inevitable from even a superficial study of the foregoing figures.

The earnings and dividends of a company operating transit lines in a metropolis like New York are not as inordinately large as the popular impression makes them. Notwithstanding the most economical engineering design and operation and the most able business management, the large fixed charges, especially the rentals in the present instance, operate to cut down the net earnings considerably, and to make the money invested yield only a moderate dividend.

The hesitancy of private capital to undertake the building, equipping and operating of underground lines can be understood when it

* Includes advertising and news privileges; sale of current; rent of land and buildings; telegraph privileges; interest and dividends on securities owned, deposits and loans.

is remembered that the cost per mile of single track of the present subway was $750,000 for construction, and $380,000 for equipment. In the equipment expenditures, the mile of track cost was $53,000 for the electric line, $78,500 for the power plant, and $113,400 for the cars.*

While the maintenance of rolling stock is minimized by up-to-date shop facilities, the labor of inspection is necessarily large. The cost of electrical energy for motive power is reduced through the enormous output of large modern generating stations. The car operation which forms the largest account (42.35 per cent) of the operating expenses, is due to the relatively large number of employees required and the comparatively high wages paid.

The total operating expenses proper are low, notwithstanding the cost of labor and material in the maintenance and operating accounts. Although it is difficult to differentiate one particular cause which is, more than others, contributory to this result, one is inclined to the conclusion that the favorable performance attained per car mile is in part due to the relatively high schedule speeds and daily mileages per car resulting from high-power motor equipments and relatively infrequent stops.

* Average of $10,200 per car.

PROFIT MAKING IN SHOP AND FACTORY MANAGEMENT.

By C. U .Carpenter.

VII. MINIMIZING THE TIME OF ASSEMBLING WORK.

Mr. Carpenter's series began in January, and the six articles heretofore presented discussed, first, the general methods of examining into the condition of any manufacturing business so as to discover the existence of waste and loss and to determine the "sticking points"; second, the nature and the working of the "committee system" of factory administration; third, the reorganization of the designing and drafting departments; fourth, the great importance and value of the tool-room as a source and spring of profitable methods; fifth, the general conditions necessary for manufacturing at minimum cost; sixth, methods for fixing standard times for manufacturing operations.—THE EDITORS.

THE study of the proper time in which to do assembling work is peculiarly difficult. It is a far more puzzling proposition than the one of analyzing and determining the proper time in which any particular part should be machined. The element of human judgment and human skill enters so largely into assembling that even the closest study will at times fail to give an altogether scientific analysis of the quickest time in which any particular job should be performed. After a workman has been on an assembling job for a number of years, his operations become automatic and can be made at a rate of speed that cannot be equalled by any man whom the superintendent may elect to "try out" the job unless he has had almost an equal term of experience. A study with the stop watch of the length of time required by the workman will often prove almost fruitless, because if the man has the slightest suspicion that he is being checked up, he will immediately slow his pace. If the job is already on piece work, the proposition becomes an especially difficult one, for the workman well knows how to keep down his rate of production while apparently keeping up a high rate of speed. It is for this reason that the study of assembling work requires particular care and especially keen analysis.

Space prevents any discussion of the essential features of the proper organization of an assembling room at this point. I will, however, emphasize the important feature that in the assembling of articles composed of many intricate parts it is highly advisable to separate the assembling operations for any particular job into as

small a number as possible. If the workman can be confined to two, or at the most three, operations the problem is not a difficult one; but where, as in many cases, the assembler will have from eight to ten different operations on a particular part, the solution becomes very difficult to find. Because of this very difficulty, it becomes of extreme importance that some solution be reached, as the waste of time in the ordinary assembling department of the average manufacturing concern is almost beyond belief. The only method of procedure that I have made a success of is as follows:

1. Classify all the work, as was suggested in the case of those parts which are to be machined.

2. Select the most skilful workman in whom you can have confidence. It will be necessary to make him an assistant foreman and hold forth to him promise of future promotion, if the desired results are to be secured. This removes him from the influence of the workmen and has a direct effect upon the problem. The workmen will rarely resent a thorough investigation made by a man under the title of assistant foreman, but will invariably bring severe pressure to bear upon the ordinary workman who attempts such work, in order to force him to use the lowest pace possible without detection.

3. Place before the Committee, the testing assemblers and the head of the assembling room, the different jobs as classified and analyze their elements to the last degree.

4. It would be well at this point to make some close observations upon the workmen who are engaged on this work. It will, however, be necessary to use the stop watch skilfully so that the time required to perform the elements of each operation can be recorded as far as may be possible. With the calculated analyses of the elements of the work, and the actual record as made by the workman, before the Committee, it is then necessary to plan a comprehensive method to be pursued in the testing of the work and in the regular assembling operations to be done by the assembling department in the future.

It will very often be found wise and, in fact necessary to classify the work on the separate jobs in a different manner from that ordinarily pursued, so that each assembler will perform only a portion of the work that he formerly did in its entirety. This action makes it easier to demonstrate to the men that the work can be done within the specified time and also assists in putting it beyond their power to conceal the best results obtainable.

5. In making these tests, it is, of course, essential to surround the tester with the best possible conditions. It is, however, necessary to

keep in mind that your assembling room must be so arranged that the same conditions can prevail in everyday manufacture. These conditions may be specified as follows:

(a) All the work should come to the tester or the assembler properly inspected so that the accuracy of the previous operations can be assured.

(b) All the parts that are to be assembled must be conveniently arranged in logical order. All necessary rivets and screws and tools of all descriptions must be placed at a point convenient to the workman and within his reach so that the least amount of effort is required to handle them.

(c) Wherever possible inspection should provide for such accuracy of parts as to make it unnecessary for the assembler to do any filing or fitting. In every case, however, where such fitting, grinding, or drilling has to be done by the assembler, the necessary machinery for doing the work must be placed as conveniently as possible.

(d) Every possible facility should be provided for the quick handling of the work. In the case of heavy parts, there should be a thorough system of hoists and cranes. The stipulations outlined under the heading of "Handling of Work" will apply here.

A very careful consideration of all of these problems and a serious attempt to solve them scientifically will bring surprising results.

I have often noted very large savings in time in assembling operations, which apparently were performed by workmen at a very high rate of speed, working under the piece-work system. A few examples of the benefits of the system advocated, taken from my own experience, may prove of interest at this point.

A few weeks ago, I witnessed an assembling job, the work of which was done according to methods which had been developed under a careful study along the lines advocated. The piece-work price on the assembling work had formerly been $2.85 per piece. The application of these newer methods made it possible for the workman to do the entire assembling job in 16 minutes, and this, too, at a pace which it is perfectly possible for him to maintain during his entire working period.

Some four years ago, I made comprehensive tests in a very large establishment on assembling work requiring a particular degree of expertness and dexterity. Inasmuch as it was impossible to secure one of the trained workmen (numbering in all over 150) who would give his very best efforts to any job that might be set before him, I took a man who was an ordinary truckman, who had never been a

mechanic in any sense of the word, and trained him for a period of five weeks before we started him to doing the testing. We naturally selected a man who was particularly bright and capable. I do, however, want to emphasize the point that this particular individual was not a trained mechanic and secured what skill he possessed only during the five weeks training mentioned above.

Allowing that each workman should earn on the average of $3.00 a day, we found that there were 286 jobs that averaged 167 per cent. too high. In other words, for every job that formerly cost $1.00 on piece work, we found the proper price to be about 38 cents. Even then the limit had not been reached, becuse of the fact that the man who was doing the work could not be termed the highest grade of mechanic. We, however, found that after six months had elapsed, he could easily earn $4.00 a day at the prices on the new basis, whereas his former earning had been $3.00 a day. Further investigation showed that in this establishment, where 4,700 men were employed, there were a number of departments where the work was quite similar but where the piece-work prices were all out of proportion, those in one department being greatly in excess of the prices in other departments doing similar work, this being due to the relative efficiency or inefficiency of the foremen in setting prices. We found upon the average that this disproportion amounted to over 23 per cent. The tests mentioned above were performed in one of the departments which was considered the most efficient. In another department—a large polishing room containing 123 men—I found another field for work of the character advocated. These polishers were supposed to be very high grade, their average earning capacity being $4.00 a day. The grinding, polishing and buffing included work upon brass, bronze, copper, sheet steel and cast iron. After the work of investigation had been under way but a short time, a strike occurred. All of the old polishers left in a body. We secured a group of 12 expert polishers from other sections of the country, and then, by offering a high day-work wage rate, we employed 62 men from the adjoining city. It is important to note that these last were men who had never been "up against" a polishing or buffing wheel, and knew absolutely nothing about the trade. Some were clerks from the company's office and others were grocery and dry-goods clerks attracted by the high wage rate. Care was exercised to see that they were strong, healthy and intelligent. Each experienced polisher was placed in complete charge of a group of five of these "green" men. This experienced polisher was under no circumstances allowed to do the work himself.

other than to show these men how to do the work and to train them in every possible trick of the trade. Extra rewards were given to these experts to get proper results from the men. In addition to this, the foreman and assistant foreman of the department, together with the writer, were in constant attendance. Unfortunately, my investigation of the elements of this work had been so handicapped by the extra work incidental to the strike that it was impossible to analyze each and every job in the department. The analyses already made, however, showed that a reduction of 40 per cent could easily be made and still provide the men with a large enough price to enable them to earn a good wage. It was our original intention to place the new men upon a day-work system of pay for a period of about eight weeks, the management presuming that very slow progress would be made for this period at the very least, many of the officers indeed claiming that proper results could never be accomplished.

The analyses of operations and the method of training was pursued so vigorously, however, that we found it possible to put the entire body of men upon piece work at the end of three weeks and a half. The new piece-work prices (40 per cent lower than the old ones) were given to these "green" men with the assurance that there would be no reductions made and that the firm would be glad to have them make all the money they could during that period.

The management was careful to see that the former rigid system of inspection was still adhered to in the case of these new men. It is a matter of record that at the end of a period of ten weeks the average earnings of the men of the department exceeded $5.50 per day. The work increased so materially that at the end of six months the actual records showed savings in the pay roll in this department amounting to over $55,000 per year.

Had there been time to make a closer time study, it would have been possible for the firm to save even a larger amount of money with the additional assurance to the workman that he would still have been able to earn a large wage.

These few examples will serve to illustrate the splendid possibilities of the methods and systems advocated.

I shall take up later the question of the system of pay to be used in case of a shop adopting systems described in these articles. It is sufficient to say at this point that I regard it as *absolutely essential that a workman receive a very considerable increase in his daily wage* for accomplishing the very desirable results which can be secured. My object in mentioning this just now is to

emphasize the fact that even with the best analyses a workman will become so skilful in time on an assembling job as to exceed to quite a large degree the calculated records, and consequently, in order to secure this extra output, the possibility of which lies hidden within the workman's skill, it is necessary to offer an additional premium.

Foremen's Co-operation.

It has been remarked to me more than once that the most difficult of all the problems connected with the introduction of such systems as those advocated is that of securing the foremen's co-operation. It is undoubtedly true that unless the hearty co-operation of the men operating the departments be secured, the system is almost certain to fail. It is safe to say that it will be almost impossible to introduce these plans in any comprehensive way with a shop organized in the ordinary manner. It is for this reason that I venture continually to bring forth the effectiveness and, indeed, the necessity for the Committees. In securing the foremen's co-operation to these plans, tact must be used. Unless the matter is handled delicately, every one of them will feel that his department is going to be "shown up," and the new record will be compared against his own record to his own disadvantage. Naturally, therefore, this consideration will lead him to covertly oppose the introduction and success of the methods at every point. When, however, these matters are considered in their presence with the Tool Room Committee and the tester, together with the tabulation, they are placed in a position where they must wheel in line and give their support to the system.

By calling all of them constantly into consultation with the Committee, they are placed in a position where they cannot defend any unfair attitude toward these methods. Give them to understand that if they have anything to say in opposition to the plans the committee room is the place to say them and, under no circumstances, tolerate a word of criticism outside of the committee room. If they are made to see that the results are obtained through new methods entirely, and that they are not to be criticized nor held responsible for the results formerly obtained under the old conditions, they will soon lend their enthusiastic support to these plans. Let me again assure any one considering the introduction of these plans that this support is absolutely necessary.

I have always found that if this important question is handled along the lines indicated, and, in addition to this, the foremen are given to understand the success of the system would mean addition to their remuneration, their hearty co-operation will be secured.

EFFICIENCY IN THE BURNING OF FUEL UNDER THE STEAM BOILER.

By William D. Ennis.

III. PRACTICAL MODIFICATIONS AFFECTING THE THEORY OF AIR SUPPLY.

The first part of Mr. Ennis's discussion, which began in our June issue, discussed the necessities of perfect combustion, and explained the bearings of flue-gas analysis. The second installment dealt specially with the measurement and control of draft. The present part takes up the modifications in practical management necessitated by various commercial fuels. Next month Mr. Ennis will demonstrate the economy to be obtained by burning the small grades of anthracite.—THE EDITORS.

THE analysis presented in foregoing articles has dealt primarily (and in theory, entirely) with a fuel assumed to be pure carbon. Certain modifications arise in considering actual fuels. These modifications, in the case of anthracite coal, which is largely pure carbon, are of slight consequence. Soft coal, however, contains a large proportion of oxygen; wood, even more; and both carry rather more hydrogen than hard coal. The presence of these bodies complicates the chemical reactions described as combustion. What are known as hydro-carbons, or combinations of hydrogen and carbon, give to soft coal its peculiar characteristics. These compounds include CH_4, C_2H_4, C_6H_6, C_2H_2 and many others. The reactions which occur in the combustion of the four assumed as typical are;

$$\begin{aligned} CH_4 + O_4 &= CO_2 + 2H_2O \\ C_2H_4 + O_6 &= 2CO_2 + 2H_2O \\ C_6H_6 + O_{15} &= 6CO_2 + 3H_2O \\ C_2H_2 + O_5 &= 2CO_2 + H_2O \end{aligned}$$

In general, the carbon and hydrogen separate, the carbon uniting with oxygen to form carbon dioxide (preferably), and the hydrogen uniting with oxygen to form steam. Oxygen is, of course, the prime requisite to combustion, as in the case of pure carbon; but with soft coal or wood, a considerable proportion of this oxygen is contained in the fuel itself, so that a rather smaller amount of air is required from external sources, for complete combustion. The furnace tempera-

tures obtained are somewhat higher. The combustion of hydrogen evolves heat amounting to 62,000 B. T. U. per pound, or more than four times the calorific effect produced by the combustion of one pound of carbon. Even after deducting the latent heat carried off by the steam produced in the combustion of hydrogen, amounting to 966 $\times$ 9 = 8694 B. T. U. per pound of hydrogen burned, the calorific value obtained is very high; and even after some further necessary deductions have been made, to include all the known modifying factors, the available heat per pound of hydrogen is over 40,000 B. T. U.

The combustion of soft coal is still further complicated by the successive reactions occurring in the furnace. When coal is first fired, there begins a rapid evolution of moisture, which breaks up into its constituent elements at a relatively low temperature, the oxygen uniting with carbon to form carbon monoxide (not enough oxygen being supplied to produce dioxide) and the hydrogen being isolated. In order to burn the carbon monoxide to carbon dioxide and the hydrogen to steam, a considerable supply of air must be provided. Under ordinary conditions, no special effort being made to maintain a high furnace temperature, the air supplied does not suffice to consume these valuable gases, for the simple reason that the temperature in the furnace is lower than that at which they will ignite. As a result, dense black smoke is produced, due to the separation of solid particles of carbon and to the evolution of mixed hydrocarbons at temperatures below their igniting points:

$$C + H_2O = CO + 2H$$
$$CO = C + O \text{ (smoke)}$$

As these smoking gases pass away, the temperature of the furnace rises, the carbon burning to carbon dioxide in an adequate supply of air. As soon as the incandescent fuel bed is pretty well burned down, the available supply of carbon for combination is decreased, and unless the ash-pit doors are closed, there is an excess of air passing through the fire. In ordinary operation with soft coal there is, therefore, but one moment when the air supply is ever in proper proportion, viz., when the hydrocarbons and unburnt carbon have passed away and the residual coke is burning freely. In nearly every case an excessive amount of air is provided during the "smoking" period, which fails to prevent smoke because the temperature is too low. This is not an essay on smoke abatement; but as relating to our subject, it should be remembered that while smoke is not usually the result of excess air, it is almost always associated with it.

For the most efficient combustion of soft coal, the air supply and draft should both be varied in accordance with the condition of the fire; the draft should be adjusted so that the distillation of hydrocarbons shall proceed slowly and in a very hot combustion chamber, the intensity of draft being increased after this distillation, while consuming the coke, if desired. If the combustion chamber is kept hot, and the air introduced in such manner as to mingle thoroughly with the burning gases, high economy due to low air excess, and practical smokelessness, are both possible.

The special reactions given, for soft coal, in addition to complicating the analysis of air supply, result in variations of furnace temperature which affect all calculations of gains or losses dependent upon the quantity of air. Thus, in the reaction

$$C + H_2O = CO + 2H$$

there is postulated a separation $H_2O = O + 2H$ antecedent to the one specified. This decomposition, the reverse of combustion, absorbs heat and cools the furnace just as the reaction $H_2 + O = H_2O$ evolves heat, amounting to 62,000 B. T. U. per pound of hydrogen.

Another practical modification of the theories offered is applicable to all fuels, though perhaps most noticeable in the case of the lower grades of soft coal. Analysis of flue gases frequently show the presence in a single sample of oxygen and carbon monoxide concurrently. The question naturally arises, why does not this oxygen unite with the monoxide to form dioxide? Even when the furnace temperature is beyond any question high enough to ignite carbon monoxide, it is not at all unusual to find fairly large percentages of this gas, unconsumed, when the air supply is entirely adequate. This phenomenon is to be explained by the failure of the gases to mix thoroughly in the furnace. There is a strong tendency for these gases to stratify, probably on account of their different densities, and this overcomes the effect of impact at the corners and angles of the combustion chamber which naturally would have a tendency to bring the gases into contact.

Arguments in favor of using pulverized coal for fuel are based on the necessarily perfect mixing of air and gas from the fuel which occurs when the latter is blown into a furnace. The necessity for more thorough mixture is recognized also in the various devices for smoke prevention involving contracted passages, baffle and wing walls, and the like.

Incomplete mixture is of course ignored in the various charts herewith presented. The figures for loss of fuel due to various percentages of carbon dioxide are based on the assumption that all oxygen

present in the gas has united with carbon to the full extent of the valency of the former. If air is in excess, but carbon monoxide is nevertheless present, then the monoxide contains some of the oxygen that would otherwise be found in a free state. Suppose we assume, for one pound of pure carbon, an air supply of x pounds, of which .23 x pounds is oxygen and .77 x pounds nitrogen. Let y be the weight of carbon burned to dioxide, then 1—y = weight burned to monoxide. The oxygen supplied in the two cases respectively will be 2.67 y and 1.33 (1—y). The flue-gas composition would then be as follows:

Carbon dioxide, $y + 2.67\ y = 3.67\ y$

Carbon monoxide, $(1—y) + 1.33\ (1—y) = 2.33\ (1—y)$

Oxygen, $.23\ x — 2.67\ y — 1.33\ (1—y)$.

The total weight of the products of combustion is the same as in our first analysis, $(1 + x)$ pounds. The weight of dioxide being 3.67 y pounds, the proportion of carbon dioxide in the gases is:

$$A = 3.67\ y \div (1 + x) \qquad (1)$$

The proportionate loss due to excess air has already been expressed by the formula

$$(x — 11.6)\ (t'—t°)\ (.2375).$$

Putting this equal to B, and letting $(t'—t°) = 500$, we have:

$$14{,}500\ B = 118.75\ (x — 11.6)$$

whence $$x = 122\ B + 11.6 \qquad (2)$$

Substituting this value of x in equation (1), we obtain, finally:

$$B = (y \div 33.2\ A) — .103 \qquad (3)$$

The value of B for the condition of perfect mixture, would be

$$B = (1 \div 33.2\ A) — .103 \qquad (4)$$

We may readily confirm this by assuming that $x = 11.6$, whence $A = .291$ and $B = 0$, as it should. The difference between the second terms of equations (3) and (4) represents the difference in loss due to heating excess air under the conditions of either partial or complete mixture, as related to the percentage of carbon, dioxide in the gases. This difference is expressed by

$$C = \frac{1 — y}{33.2\ A} \qquad (5)$$

This expression is positive for all possible values of y, and we note therefore that the percentage of fuel lost by heating excess air is less than that shown on the chart, Figure 2,* for any specified percentage of dioxide.

There is, however, a definite loss due to incomplete mixture, which tends to offset (and usually does offset) this technical gain. We have

* THE ENGINEERING MAGAZINE, June, 1907, page 425.

seen that (1 — y) pounds of the fuel are burned to carbon monoxide, involving a loss of (1 — y) (14,500 — 4,400) B. T. U. The loss bears the proportion to the total fuel heating value of

$$\frac{10{,}100\ (1 - y)}{14{,}500}$$

If we set this quantity equal to the expression (5), we find A = .0433, or at that percentage of carbon dioxide equal to 4.33 per cent of the total weight of gas, the reduction of loss in heating excess air is counterbalanced by the loss due to the production of carbon monoxide. If A is increased, B decreases; and vice versa; so that when the percentage of carbon dioxide is greater than 4.33, the total net result is an increase of loss; when less than 4.33 per cent, the net result is a decrease of loss. These modifications give the dotted curves of Chart II, crossing the main curve at the point where carbon dioxide amounts to 4.33 per cent of the total weight. This would be reduced to percentage by volume in plotting the curve as described below.

This modification of the theory of loss ignores the fact that incomplete mixture always tends to excessive decrease of furnace temperature, both on account of the excess air and by reason of the formation of carbon monoxide. With the furnace temperature considered, there can be no question but that incomplete mixture always increases the amount of fuel wasted; and even if this factor be neglected, the variation in loss from that shown by the main curves of Chart II, is so slight that the steam producer cannot form any other than a purely technical exception to the validity of that curve.

To reduce the percentages by weight to those by volume, for CO_2 = 4.33 per cent, we find y = .0118 (x + 1).

Gas.	Weight.	Relative Volume.	Actual Volume.
Carbon dioxide	.0433 (x + 1)	.0909	.00393 (x + 1)
Carbon monoxide	2.29 — .0275x	.143	.328 — .0039x
Oxygen	.216x — 1.273	.125	.027x — .159
Nitrogen	.77x	.143	.11x
Total.....	(x + 1) approximately		.137x + .173

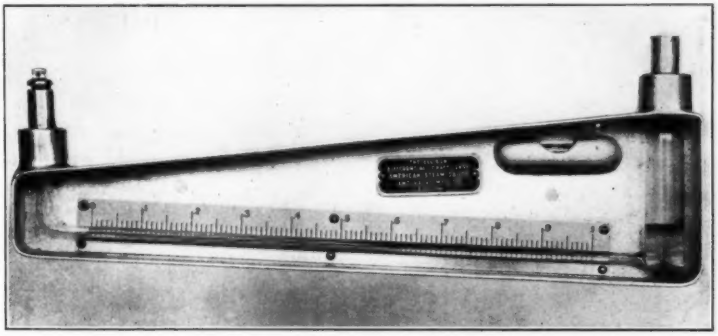
The ratio of carbon, dioxide to total gas volume is, therefore

$$.00393\ (x + 1) \div (.137x + .173)$$

which, for values of x above 1, amounts practically to .0287. The percentage 2.87 therefore represents the crossing line of the main and dotted curves of Chart II. So low a percentage of dioxide is seldom found in practice concurrently with monoxide and free oxygen, so that generally speaking the presence simultaneously of these last two

gases is an indication of losses greater than the theoretical for all ordinary percentages of carbon dioxide.

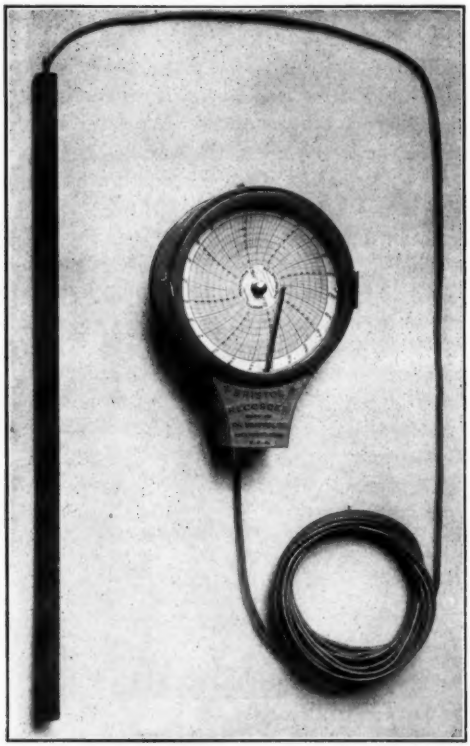
There is a further modification of the theory, from which it is not so easy to escape, and which may offset our having thus far ignored the wastes due to lessened furnace temperatures. We have heretofore, in calculating the excess air losses, taken the specific heat of the products of combustion at .2375. This is the correct figure for air at constant pressure within usual ranges of temperature. For such high temperatures as are found in boiler furnaces, it is probably too low. We know that the specific heats of steam and other gases increase with the temperature. If this is true also of air, then the theoretically possible temperature of the furnace will be lowered and the loss due to excess air increased.



ELLISON DIFFERENTIAL DRAFT-GAUGE.
Designed by Lewis M. Ellison and manufactured by the American Steam Gauge & Valve Co., of Boston. Made right and left hand, the largest (3-in.) size having a 15-in. scale, 20 divisions to inch. Reads either pressure or vacuum, according to which end is connected with the flue or furnace. The liquid used is mineral seal oil.

Further, the various gases present during combustion differ slightly in specific heat. The specific heat of carbon dioxide is given as .217; of steam, .475; nitrogen, .245. These differences of specific heat modify slightly the calculations as to the temperature attainable in the furnace and the loss due to excess air; but the modification is not more than a very slight one, in the latter case.

Another more significant factor is the phenomenon of dissociation. It has been found that gases partially decompose, absorbing heat, at temperatures far below those at which their constituent elements will unite in combustion, evolving heat. Thus, carbon dioxide begins to break up into carbon and oxygen at a temperature of about 2,100 degrees; steam similarly breaks up into hydrogen and oxygen at about



BRISTOL RECORDING THERMOMETERS, FOR CONTINUOUS REGISTRY OF FLUE TEMPERATURES.

The instrument is a delicate gas pyrometer, the changes in the registering bulb being transmitted any ordinary distance through the small tube to the recording dial. The Bristol Company, Waterbury, Conn.

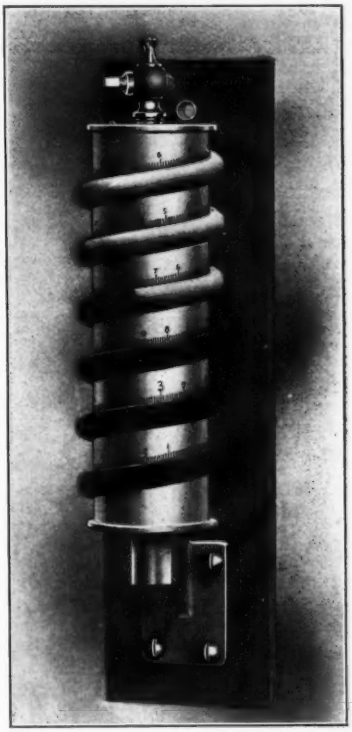
the same temperature. Fortunately, however, the amount of decomposition thus occurring is small, being alalogous to the evaporation of water into invisible vapor at temperatures below the boiling point. So far as it occurs, however, this decomposition in the furnace is a source of loss; just as much heat being reabsorbed and carried off by the separation of dioxide into its constituents as was evolved by the union of those constituents.

The modifying effect of various fuel constituents other than carbon, hydrogen, and oxygen, has not been considered. The most important of these constituents is sulphur; but as percentages of sulphur above 2 per cent render the fuel unfit for use in steam-boiler furnaces, the practical consequences of the presence of sulphur are slight.

With the high furnace temperatures necessary for high economy, as evidenced by the foregoing analysis, it is obvious that radiation losses from the furnace and setting will be increased. To hesitate on this account from getting the highest possible temperature would logically lead eventually to putting the fire out as the most economical step possible. That high percentages of carbon dioxide, and the com-

pact fire with the limited air supply necessary therefor, may result in some increase of loss due to unburnt fuel in the ash is probable; but as the total loss to the ash need not exceed 2½ per cent, it is of small importance as compared with the losses due to excess air.

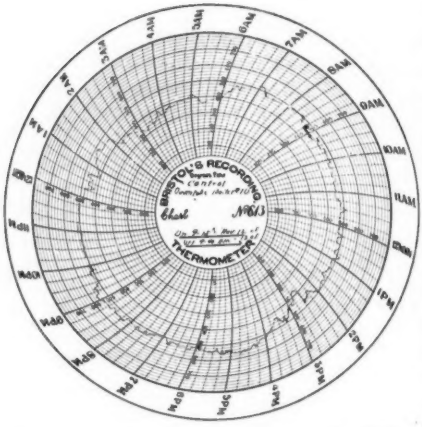
High rate of combustion appear to be most conducive to high percentages of dioxide. This is no doubt partly due to the difficulty of cutting down the air supply to a sufficiently low point. Dampers, ash-pit doors and brick settings always leak more or less, and sometimes it seems as if the air were able to go straight through sound brick and mortar. Being unable to get the quantity of air reduced to where it should be, we do the next best thing, and increase the amount of coal until it begins to correspond with the air supply. Consequently, highest economy is now secured, with soft coal, at a combustion rate of 25 to 30 pounds, whereas a few years ago it was thought that 16 to 18 pounds was the maximum rate permissible. We may eventually find that there is a most efficient rate of combustion for each coal, depending on the limiting thicknesses of fire, under practicable conditions of cleaning, with regard to avoiding holes in the fuel bed. Such most efficient rate of combustion will certainly be higher than those formerly suggested.



SARGENT DRAFT-GAUGE.

Direct-reading, with 6-in. range reading to 0.01 in. The helical tube is celluloid, surrounding a nickel-plated brass cylinder. The liquid is water. Sargent Steam Meter Co., Chicago.

An important note should be made here. With high rates of combustion, we must be careful not to advance beyond the capacity of the boiler heating surface to absorb the heat generated from the coal. The old ratios of heating surface to grate surface will probably have to be revised, if in the future we are to work at



RECORD OF FLUE TEMPERATURES MADE WITH A BRISTOL RECORDING THERMOMETER.

combustion rates of 25 pounds and upward. A high rate of evaporation per square foot of heating surface, beyond a rather uncertain limit, will certainly be detrimental to both economy and capacity. Our boilers must be large in proportion to the grates, and—a matter of even greater importance — the gases must be so baffled as to come into contact with every square foot of the heating surface, without the short circuiting usual in horizontal and some types of water-tube boilers. High combustion rates no doubt give some gain by reason of crowding the gases, and to a certain extent, compelling them to mix; but we must not abandon other methods of producing the most thorough mixture possible and of bringing the gas into contact with every foot of every tube in the boiler.

High rates of combustion and high percentages of dioxide may result, under present conditions of boiler design, in increased escaping temperatures of flue gases. The loss of heat due to such increased temperature is proportioned to the amount of air supplied. To cut down the air supply from 23.2 pounds to 11.6 pounds would result in a sufficient saving to permit of doubling the temperature of escaping gases. There is little danger that the gain due to decreased air supply will be greatly reduced by reason of losses due to increased flue gas temperatures.

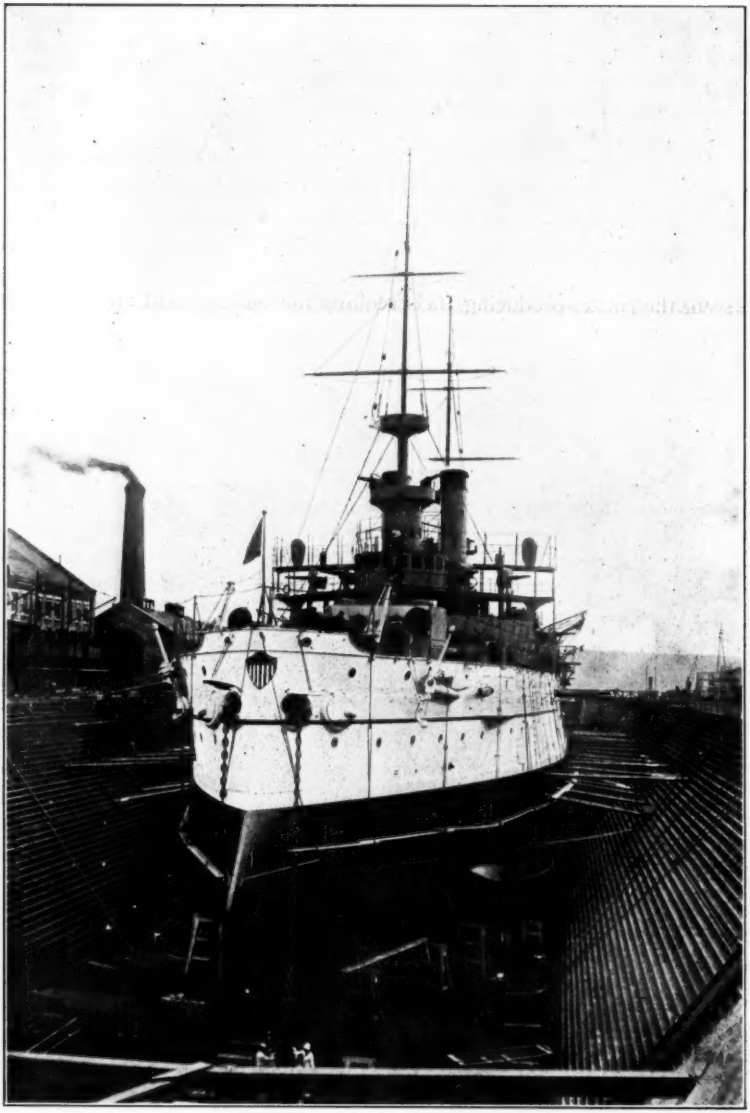
Such intensified combustion may increase boiler repairs; but the objection thus raised against a normal and reasonable air supply is kindred to that made on account of increased radiation loss. Our boiler repairs would be least if the boilers were not operated at all. If they must be operated, then operate them to the best advantage. It is my belief, founded upon observation of plants in many industries and using nearly every kind of fuel, that the average loss of fuel due to excess air alone would pay the expense of replacing the boilers every year or eighteen months.

Close regulation of air supply increases the tendency to smoke

production. This cannot be gainsaid. Nevertheless the plants which are economical with regard to air supply are not the smoke-producing plants. The closer attention to furnace operation which is essential to correction of air supply involves control of those factors which tend to produce smoke. If smoke production were inseparable from diminished air supply, this would be of economical consequence only where smoke constitutes an hygienic menace. The losses due to smoke are insignificant as compared with those due to excess air. The presence of smoke is, however, an indication that something is wrong with the air supply; and as this error is almost always in the direction of excess, smoke is usually significant of important losses. As we have seen, the smoke-producing fuels require, not an increased air supply, but an adjustment of air supply to the changing conditions of the fire, an unusually perfect mixture of gases, and a continuously high furnace temperature.

The question may be asked, why is any excess of air necessary? Under the best operation yet recorded, an excess of air of about 30 per cent is found. Why should this excess exist? The explanation lies in the difficulty of mixing the gases. There is always some stratification, always some layers of oxygen which have failed to enter into combination. We must therefore provide such excess as will cover this loss of available oxygen, and the loss as yet has not been brought below 30 per cent. Possibly it may eventually be reduced by improved furnaces and combustion chambers, which will deflect and commingle the flames. The resulting furnace temperatures will be higher, and more destructive to grates and firebricks; but as conditions demand it, methods of design and materials of construction will be found to meet those conditions.

It would be a most desirable thing to fit up an experimental boiler with which these subjects might be investigated with such degree of thoroughness as their importance justifies. No manufacturer or power producer is willing to carry on experimental work unless comparatively quick results are probable. Ways and means of further reducing air supply and abating smoke must therefore be sought in the laboratory. A test boiler of moderate size, fitted with fuel, water, and air-weighing and analyzing equipment of perfect accuracy, and equipped with time and labor-saving devices to permit of continuous operation by one or two men, might lead to results that would have a bearing on furnace design and the operations of combustion, corresponding to that which the classic experiments of Isherwood have had on the design and operation of the steam engine.



U. S. S. WISCONSIN IN THE DRY-DOCK, BREMERTON.

THE POSITION AND EQUIPMENT OF THE PUGET SOUND NAVY YARD.

By H. Cole Estep.

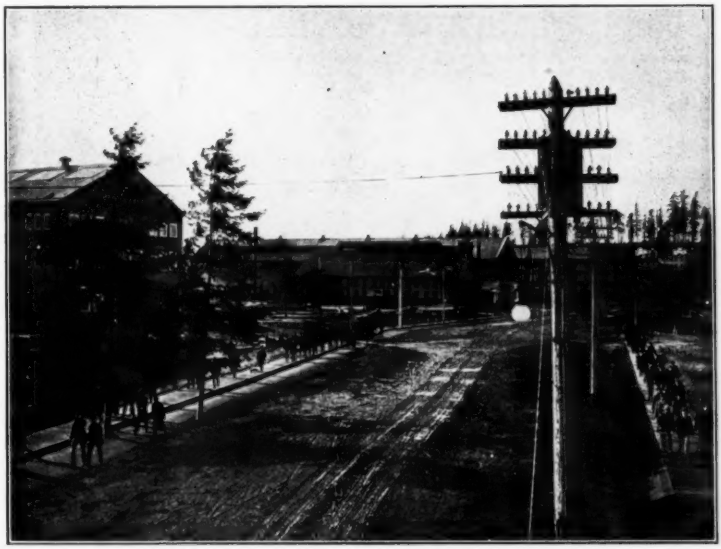
The exploitation of any present possibilities of war with Japan belongs to the sensation monger. We can not believe that the situation existing, even if difficult, will be so handled by either government that any but a peaceful solution will be reached. But it is certain nevertheless that the future interests of the United States, both commercial and military, will be increasingly concentrated on the Pacific; and now that attention is drawn that way, even if over-feverishly, the season is timely for this study of the resources by which America could hope to maintain an effective fighting force for the defence and support of her western coasts and Far Eastern possessions. Mr. Estep's study is based on the latest data and on observations on the ground, but just completed.—THE EDITORS.

EVERY person of ordinary intelligence realizes that the efficiency of the navy depends as much upon the maintenance of a system of well distributed, serviceable repair and equipment stations as it does upon keeping in commission a large and effectively disciplined fleet of fighting ships. Appreciating the truth of this, the Navy Department of the United States has entered upon a policy of using a large portion of the naval appropriation for the construction and improvement of navy yards and Congress has from time to time wisely appropriated special funds for this purpose. In the near future more money than ever before will be spent on building new, and improving the old, navy yards. Connected with these expenditures are several important questions regarding their proper administration. One of the most vital of these is the question where the improvements shall be made and upon what particular stations the bulk of the money shall be spent. Should most of the new dry-docks and repair facilities be established on the Atlantic or the Pacific coast, and if on the latter, where? It is for the investigation of this question that this paper is written.

It is the opinion of a number of naval experts that New York and the other important navy yards of the Atlantic coast are, for the present at least, sufficiently well equipped already and that the energies of the Department should be spent in improving the facilities on the Pacific. It has come to be a trite saying that the naval battles of the future will be fought on the Pacific Ocean. The ever present and apparently growing friction with the Japanese which presages

GENERAL VIEW OF PUGET SOUND NAVY YARD AND DRY-DOCK. TOWN OF BREMERTON IN THE BACKGROUND.

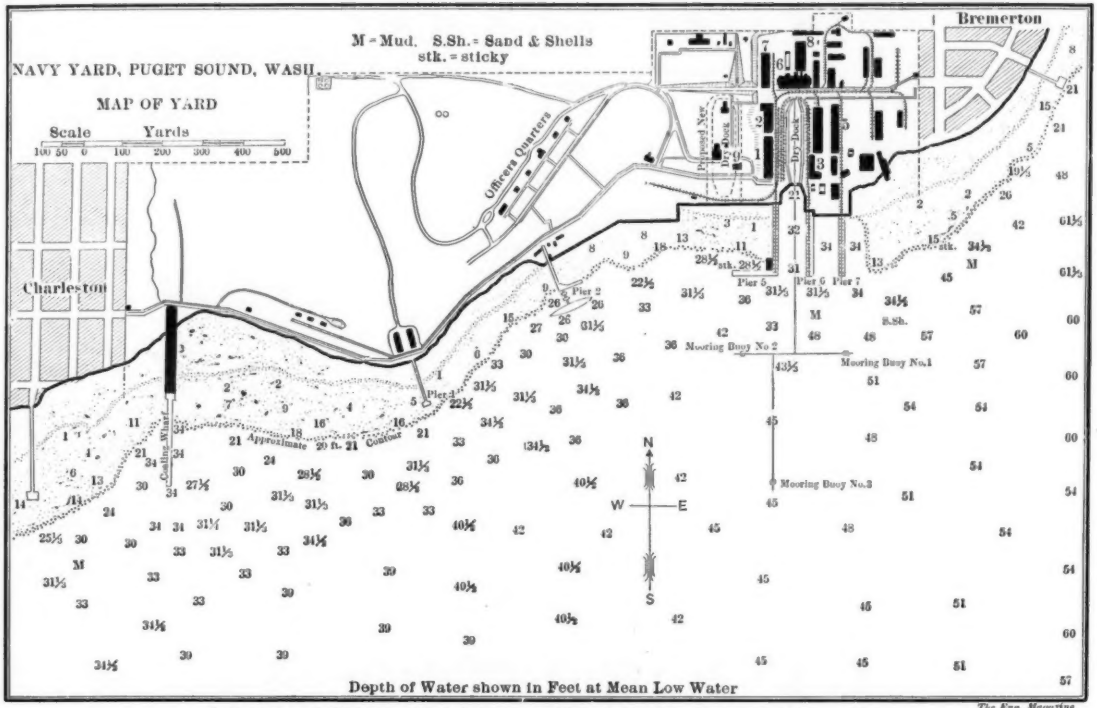
war either in the immediate or distant future, the continual delicacy and complexity of conditions in the Far East, as well as our own extensive and valuable island possessions in the Pacific, all point to the truth of the above statement. The completion of the Panama Canal will be of material aid in concentrating the American fleet on the Pacific Ocean should the occasion arise, but even with the Canal in operation the dry-docks of the Atlantic are too far away and too difficult of access to be of any use. Dependence for repairs and dry-docking facilities must be placed upon the naval stations located on the Pacific coast of the United States. It is vitally important that these stations be thoroughly and completely equipped. Are they?



THE MAIN ENTRANCE TO THE PUGET SOUND NAVY YARD, BREMERTON.

There are but two navy yards of any importance located on the Pacific coast, situated respectively at Mare Island, near San Francisco, California, and at Bremerton on Puget Sound near Seattle, Washington. Without intending to belittle in any way the efficiency and importance of the Mare Island Navy Yard we must recognize that its situation is unfortunate at the best. The channel leading to the yard is shallow. Ships leaving the dry-dock, outward bound, have got their sea valves and bottoms full of mud.* A large, new dry-dock is being constructed at Mare Island, but on account of the early trou-

* We understand the channel improvements made by Admiral Rousseau have corrected much of this trouble.—ED.



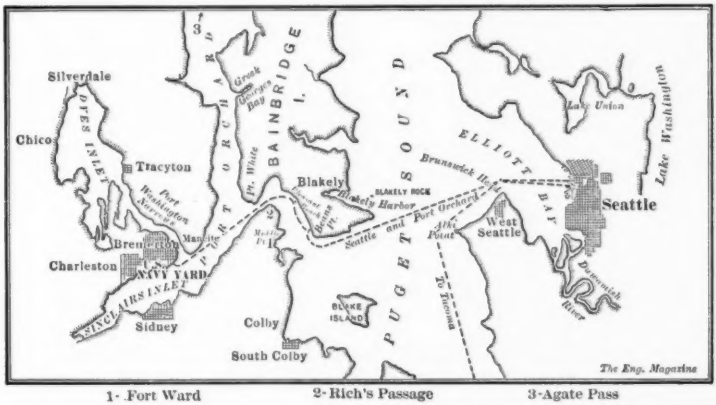
1- Boat Shop. 2- Equipment Bld. 3- Pumping Plant. 4- Machine Shop. 5- Ship Fitters' Shed.
6- Machine Shop. 7- Boiler Shop. 8- Foundry. 9- Office.

The Eng. Magazine

PUGET SOUND NAVY YARD, SHOWING GENERAL ARRANGEMENT AND CHART OF SOUNDINGS.

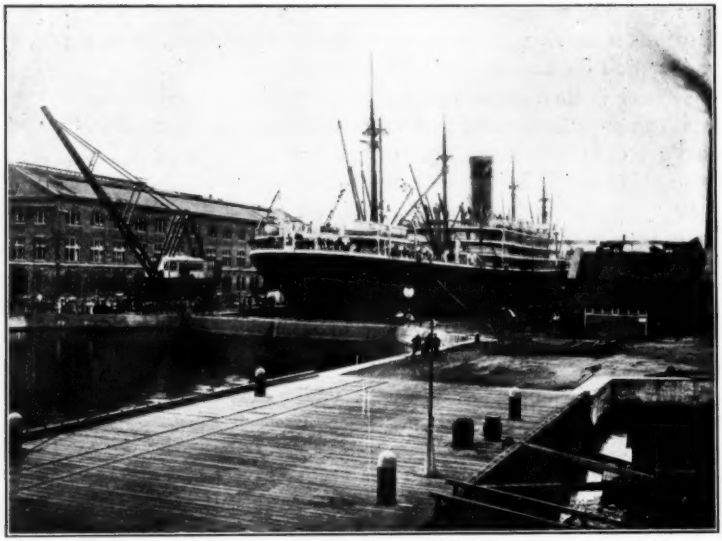
bles with the foundations its completion will require some time yet. At present the dock is too small to handle large ships, being approximately half the size of the Bremerton dock.

There is then at present but one dry-dock on the whole Pacific coast that could be used in case of immediate necessity for docking and repairing the largest battleships, of the "Wisconsin" and "Nebraska" type. It is the dock at Bremerton. Inasmuch as we have found that this dock is the only adequate one at present and that for some time to come the Pacific fleets must depend on the Puget Sound Navy Yard, and upon that alone, for repairs, we will investigate this yard more in detail. Is it properly located, well protected and thoroughly equipped; if not, what is lacking?



MAP SHOWING GEOGRAPHICAL AND STRATEGIC POSITION OF PUGET SOUND NAVY YARD.

The Puget Sound Navy Yard is located at the head of Port Orchard, an inlet from Puget Sound, in Kitsap County, Washington. The yard is approximately 130 statute miles from the open sea; is 2,400 miles from Honolulu, 4,000 miles from Panama, and 6,000 miles from Manila. It can be said without exaggeration that the yard is the best situated naval station in the world. The site, which was originally selected by Lieut. A. B. Wyckoff, U. S. N., in 1880, lies on the shores of Sinclair Inlet at the extreme southern end of Port Orchard. It is 16 miles from Seattle. There are two channels leading from the main sound to the navy yard, one from the north through Agate Pass and the other from the east through Rich's Passage. The Agate Pass route is too shallow for anything but shallow-draught sound steamers, while the Rich's Passage channel is deep and wide enough for the largest battleship, five fathoms being depth at the



GREAT NORTHERN STEAMSHIP COMPANY'S S. S. DAKOTA IN THE BREMERTON DRY-DOCK.
She taxed its capacity to the utmost.

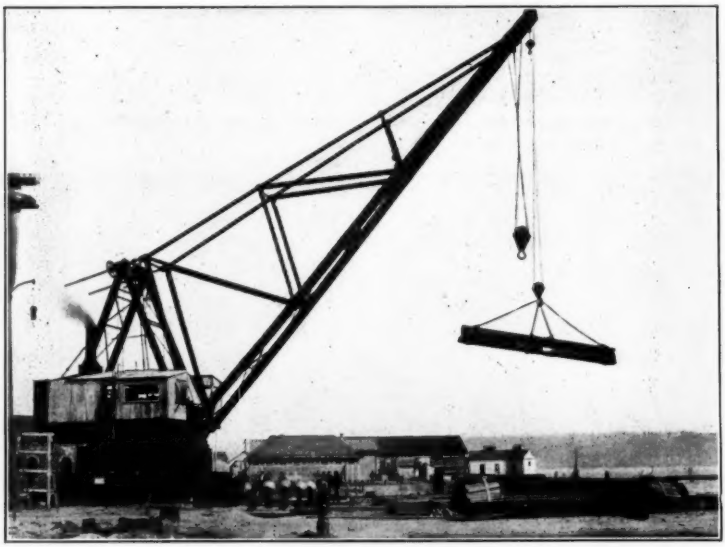
shallowest point at mean low tide. The bottom is coarse gravel. Except by a long detour around the head of the Sound the navy yard is unapproachable from the land side. The yard has no railroad connections except by means of car ferries operated from Seattle. This has proven to be somewhat awkward in the handling of heavy machinery and guns, but the invariably calm water between Seattle and Bremerton makes the operation of car ferries and barges a simple matter. The mean change of tide at Bremerton is 7.97 feet. The bottom of the bay descends quite rapidly to a depth at mean low tide of 30 feet, sufficient to float the largest man-of-war. After reaching this depth the bed of the bay descends slowly to the middle where a depth of 60 feet is reached. The tidal currents are scarcely perceptible, while those encountered in entering and leaving through Rich's Passage are well-known and harmless. Port Orchard Bay, the harbor in front of the navy yard, covers an area of about three square miles, thus affording secure anchorage, with excellent holding ground in from six to eight fathoms, for at least fifty men-of-war. The yard is located at some distance from any commercial ports so the use of the harbor will never be interfered with by merchant vessels. The bay is closely land-locked, the only entrance to it being a channel not over a half a mile wide. The high hills and bluffs that surround this

channel afford ample protection against storms. Violent winds never occur in this region, and the waters of the bay are at all times so quiet that even small craft such as row boats and small launches are secure. At the extreme head of the bay, about three miles distant, is a very small stream of fresh water. This water is clear and no sediment whatever reaches the harbor. It was these facts that lead Lieut. Wyckoff, Captain Mahan and others to select this spot for a large navy yard. Admiral Bradford, U. S. N., has summed up the situation thus:

> "There is but one good harbor on the Pacific coast in American territory and that is Puget Sound. If you travel thence southward you will have to go clear to Mexico to find a harbor which, like Puget Sound, is safe and reliable at all seasons of the year, at all stages of the tide and during all kinds of weather.
>
> "The dangers to navigation at the entrance to the bay of San Francisco are well known to nautical men. So also are those at the mouth of the Columbia River. Battleships of the larger class have no access either to Portland or to the Government dry-dock at Mare Island. We can get into Port Orchard in all kinds of weather. The naval station at Bremerton is far enough removed from the boundary line to make it safe for the repair and equipment of vessels of the United States navy even in time of war. Because of the depth of water, the shelter from storms, and its easy access from the ocean, the Puget Sound Navy Yard has paramount advantages."

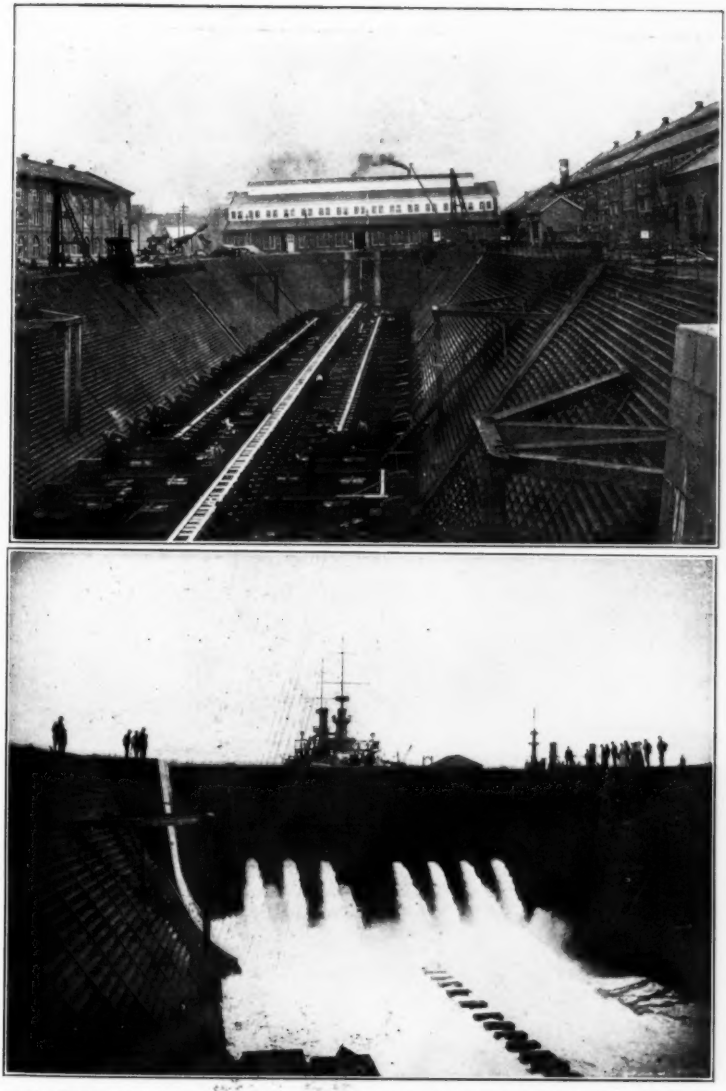
REPAIRING THE PIER JUST SOUTH OF THE DRY-DOCK.

On account of its situation the yard would be practically impregnable in time of war. Three distinct systems of forts have been established for its protection. They are Forts Flagler, Casey, and Worden near the entrance to Puget Sound, Fort Lawton on Magnolia bluff just north of Seattle, and Fort Ward situated on both sides of the channel at the entrance to Rich's Passage. The passage in front of Fort Ward is one mile wide, but on account of the Orchard rocks, located a quarter of a mile from the east shore, the width of the channel is but half a mile. About a mile from the entrance are located the narrows and here the main channel is but 440 yards wide. From this it appears that the problem of effective protection is a simple matter. Rich's Passage is the only way by which the navy yard could be reached by a hostile fleet. We have seen from the foregoing that so far as situation is concerned the Puget Sound Navy Yard is unrivalled. We shall now turn to the matter of equipment.

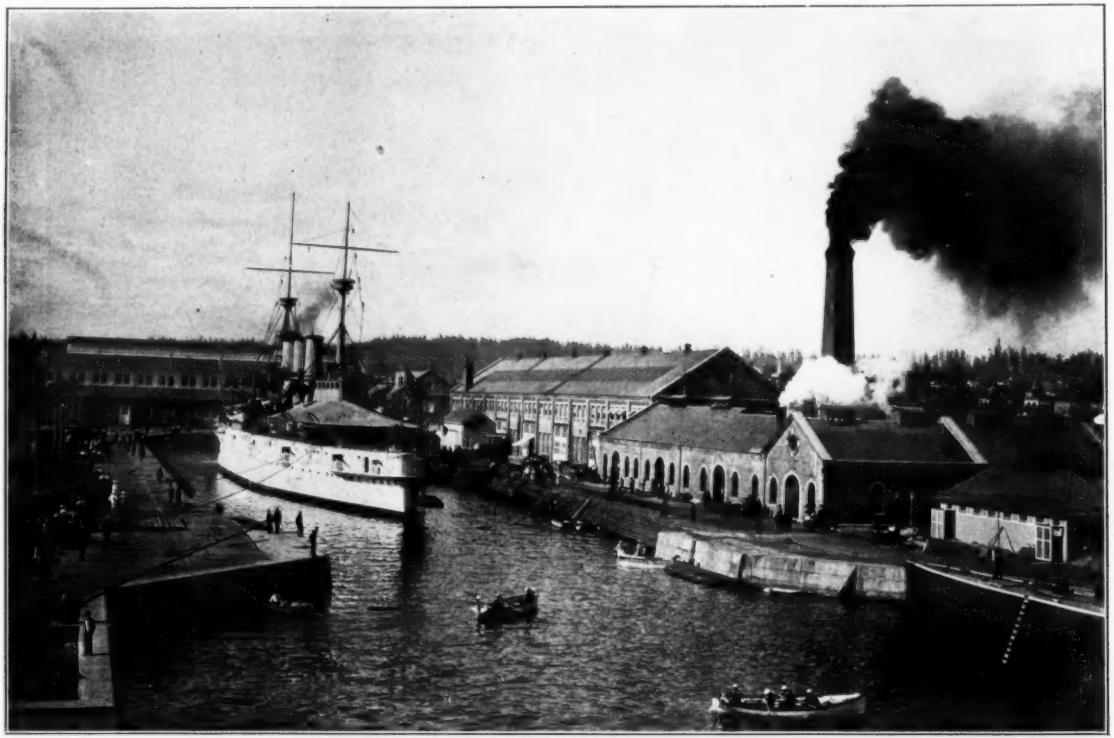


THE 40-TON CRANE SERVING THE DRY-DOCK.

The yard covers an area of 200 acres and employs an average force of 630 men. The present dry-dock is constructed with a concrete bottom, wooden sides, and concrete coping. Its length is 650 feet, width at top 130 feet, at bottom 67 feet, and depth 39 feet. It cost $700,000 and is the third largest in the world. An efficient pumping plant is maintained in connection with the dock. There are two ma-



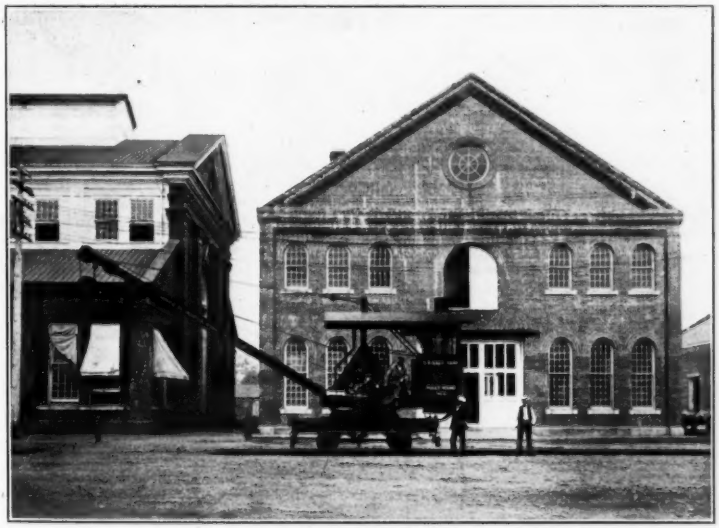
THE LOWER VIEW SHOWS THE FILLING OF THE DRY-DOCK PREPARATORY TO DOCKING THE U. S. BATTLESHIP NEBRASKA. THE UPPER, TAKEN IN THE OPPOSITE DIRECTION INSIDE THE PONTOON, SHOWS THE DOCK EMPTY.



U. S. S. NEW YORK IN THE DRY-DOCK AT BREMERTON.

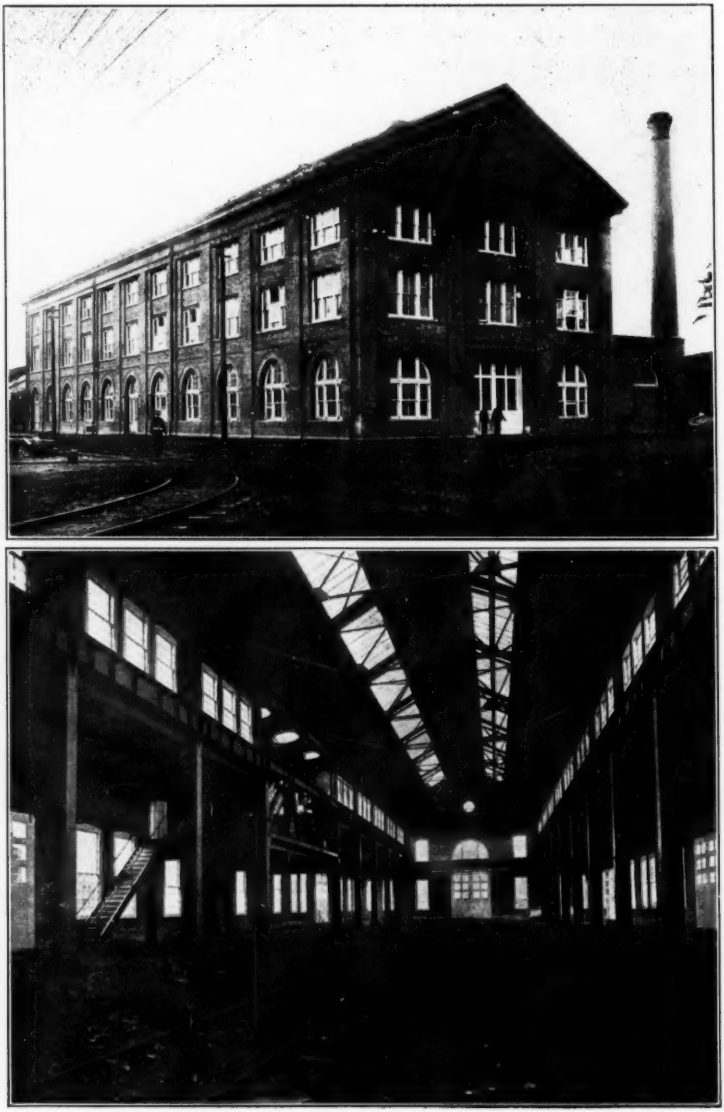
The dock was being pumped out when the photograph was taken. The pumping station and the construction and repair department machine shop are seen on the right.

chine shops. The larger, belonging to the department of steam engineering, is 200 feet by 96 feet and is fitted with an ample equipment of heavy machine tools. The shops are motor-driven on the group system, but there is no central power station. There is also a forge shop and foundry similar in size and adequacy of equipment to the machine shops. All these shops are well designed and placed and are fitted with traveling cranes and other devices for the rapid and economical handling of heavy materials. In addition to the metal-working shops there is a corresponding equipment of wood-working shops, a boat shop, a paint shop, and an equipment building. The yard is provided with a standard-gauge railway, which together with a 40-ton and several smaller jib cranes serving the dry-dock, affords an effective and efficient system of internal transportation. The total investment in the navy yard is $3,000,000. In general the present equipment, as far as it goes, is complete, serviceable, and efficient.



SMALL PORTABLE CRANE IN FRONT OF THE SHEET-METAL SHOP.

But has the United States Government gone far enough? Are two navy yards, each small compared with the great plants on the Atlantic, with only one dry-dock large enough to hold a battleship, sufficient for the important and growing needs of the Pacific? Every person at all familiar with the situation thinks not. The Bremerton plant, being the more favorably located, should be doubled in size. In case of any trouble in the near future, the Pacific fleets with only



EXTERIOR AND INTERIOR OF THE EQUIPMENT BUILDING, PUGET SOUND NAVY YARD.

OFFICERS' QUARTERS IN WINTER, PUGET SOUND NAVY YARD.

one adequate, well-protected dry-dock at their disposal would be seriously handicapped. In view of the present delicacy of the Japanese situation this lack of sufficient repair facilities might result in disaster. Some steps have been taken to improve matters. The construction of a new concrete dry-dock at the Puget Sound Navy Yard, to cost $1,500,000 and to be 750 feet long, has been authorized. Construction will begin immediately, but it will be several years before this dock is finished. Aside from this, but few improvements are contemplated. There is needed to put this station in a position to do the work that at any time may be required of it an additional expenditure of $7,000,000, including a large floating crane, a marine railway for small vessels, a central power station to replace the present uneconomical system of separate plants, and about double the present equipment of foundry, forge, machine and wood-shop facilities.

If these improvements were made the naval stations of the Pacific coast would be equal to any emergency. It is essential to the welfare and safety of the United States that this be done and that the Pacific coast be provided with navy yards commensurate with its importance as a theatre for naval operations.

THE VALUE OF THE INDICATOR IN REFRIGERATION WORK.

By Dr. Joseph H. Hart.

THE value of the indicator in steam-engine design and operation is well-known. It is in common use in valve setting and in the determination of the efficiency of a steam engine. The form of the indicator diagram, the meaning of the various parts of the curve, and the significance of variations from the standard type are more or less familiar to all, if the application is to the steam engine. But in its application to the compressor—with ammonia or carbon dioxide, as used in refrigeration, or with air in the many industrial applications of compressed air—it is not so universal in its utilization. Indeed, many refrigerating-machine manufacturers regard its use as absolutely unnecessary in the setting up and regulating of their machinery and advocate the thermometer as thoroughly efficient and quite sufficient for their work. Even some text books on the use of the indicator make an equivalent statement in regard to this one of its applications. Most engineers, however, who are thoroughly familiar with this instrument both from a theoretical and practical viewpoint are in accord in regard to its usefulness in this field.

There is no doubt that the indicator, or rather the indicator diagram, is just as useful in refrigeration as it is in steam-engine work. Its limitations here are its limitations in steam-engine work as well. There it merely records variations in pressure in the cylinder in conjunction with variations in cylinder volume as dependent on the stroke of the piston. It performs the same function in its application to the ammonia compressor. In steam-engine work it takes no account of the temperature of the steam except as this can be deduced as a function of the pressure and volume. Nothing can be learned from it about the degree of superheat in the steam, the amount of moisture in it, or the quantity of steam which passes through the cylinder at each stroke of the piston. In the same way there can be obtained from it in its application to the ammonia compressor nothing concerning the degree of superheat in the ammonia gas, or its temperature or the amount of liquid or vapor carried over in the gas or evaporated in the

compressor itself. Many of these latter points can be obtained, or at least approximately calculated, from the thermometer reading, in both steam and ammonia work. The fact that these latter properties have a much greater significance in refrigeration than in steam and power production is the excuse for the ordinary opinion. Steam is never supposed to enter the cylinder partially condensed, and the object of all work is to avoid this condition as much as possible and to use only dry and superheated steam. In refrigeration, however, especially in wet compression, a special feature is made of the advent of liquid ammonia into the cylinder chamber and its further evaporation therein, partially or completely, as the result of the heating produced by compression. These variations are all due to the fact that in steam work the effort is always to keep the heat in the cylinder, whereas in ammonia work the object is to get it out of the cylinder as fast as it is produced.

These conditions give, of course, an entirely different conception of the indicator work and its relative importance in the two cases. In the first case, in the steam engine, *work* is the object to be obtained and heat is of minor significance. In the second case, that of ammonia compression, *heat* (or rather its removal, producing refrigeration) is the important factor, and work becomes of minor significance. The indicator diagram is essentially a work instrument, and only to the extent that work is important is this development important. The indicator performs precisely the same duty in the two cases. It is invaluable in valve setting, in both steam and ammonia work, and no adequate conception of either the steam engine or the ammonia compressor as a machine can be obtained without its use. Knowledge in regard to pressure in both cases and total work done in expansion and compression can be obtained in no other way. Of course, if it makes no difference what quantity of work is done by the compressor in refrigeration, or what amount of steam is used, the indicator is not necessary. If refrigeration only is considered the thermometer is quite sufficient. The same data can be obtained in steam work from the use of thermometers and by measuring the water consumption of the engine as can be obtained by the use of the thermometer and by metering the ammonia, which is done practically by measuring the refrigeration produced in the cooling coils. It can be stated as a general fact that the compressor as an efficient machine from a work point of view has not been sufficiently regarded by refrigerating-machine manufacturers, and hence the low estimate in which the indicator and its usefulness in this field are held. There is no doubt that

an increase in its use would result in an increased efficiency in all plants when such diagrams are taken regularly and studied to show what improvements are possible and desirable.

Now in order to understand its significance in this work we will take up and discuss the standard diagram and its meaning in compression, and also state the significance of the usual variations from this type, paying particular attention to its relation to the thermometer and temperature and refrigeration throughout this development. In order to do this more thoroughly and to understand its various features more clearly, we will take up the steam diagram at the same time and point out the analogies and contrasts between the two throughout the entire cycle. The general shape of the diagrams in the two cases is the same. In both these should consist of the two horizontal lines one above the other, the lower always being longer than the upper and the two connected on one side by a vertical line and on the other by a curved line, curving toward the lower straight line. The object in steam work is to get the greatest amount of work for the least steam consumption; in compression, on the other hand, to get the greatest amount of compression for the least work done. Now the upper straight line in the steam diagram represents the portion of the stroke during which steam enters the cylinder, and its distance from the lower line represents its pressure above that of the exhaust. Hence this must be as far above the lower line as possible, or the pressure of the entering steam must be as high as possible, in order to get the greatest amount of work; and the line must be as short as possible, as its length is always proportional to the amount of steam that enters the cylinder per stroke of the piston. Of course, the area of the diagram represents work, being equal to the pressure times the change in volume, and by making the upper line longer, we get a larger area and hence more work done per stroke of the piston, but we use more steam and the object is to get ordinarily the greatest proportionate amount of work from the steam. In overloads, of course, the time of cut-off is extended and we have varying lengths of cut-off, often automatically regulated by the governor, so that the engine runs uniformly independent of the load. In these cases, the engine does more work, but it uses a much larger proportionate amount of steam and its efficiency is lowered. In the best engines, the cut-off is made to operate under normal circumstances so that the greatest proportionate amount of work is accomplished at the best efficiency from a steam-consumption point of view. This is the same as saying that the rest of the curves in the diagram are so proportioned and

have such relations that with this particular length of the upper line, or steam consumption, the greatest area, or work done relatively, is obtained. The remainder of the expansion after the cut-off should be adiabatic for most efficient work. In other words, the remainder of the upper line in the indicator diagram should be part of an adiabatic curve. An adiabatic line is steeper than an isothermal, and hence the latter would give a larger area to the diagram and therefore more work, but in this case heat would have to be added during this change and this extra heat would not be utilized at its best efficiency. In practice the curve is even steeper than an adiabatic, on account of the cylinder condensation and the accompanying loss of heat. Steam-jacketing the cylinder is done sometimes to eliminate the cylinder condensation and this tends to make the curve isothermal as well, but the full result is never obtained in practice.

Now in the compression diagram, on the other hand, the upper half represents the compression part of the stroke. The ammonia gas or air is compressed adiabatically until the other valve opens, and during the remainder of the stroke the line should be horizontal while the gas is leaving the compressor and entering the condenser. In the compression diagram the length of the upper horizontal line is proportional to the quantity of ammonia gas leaving the compressor, and hence is proportional to the refrigeration produced. The area of the diagram is, of course, the work done on the gas by the compressor, so the object in this application is to get the upper line as long as possible. The area of the diagram becomes less the nearer the upper line is to the lower, or the nearer the condensing pressure is to the suction pressure. The colder the condensing water and the larger the condenser, the less will be this pressure; therefore this development explains the reason and the manner in which the temperature affects the efficiency of the plant and the amount of work required in refrigeration. Of course, if the upper straight line is not horizontal but continues to rise with further compression, it means that the condenser is too small to take the extra charge from the compressor without extra work, and this represents a cut in efficiency also, since the pressure at which the valve opens is the pressure at which the condenser can work if its capacity is not overcrowded. Further, the compression up to this point is generally adiabatic, since all the work done on the gas appears as heat in it, and this has little chance to escape. The adiabatic curve is steeper than an isothermal, and hence in order that the area in the diagram, or the work done, shall be a minimum, it is desirable that this compression be isothermal, and the

temperature of the ammonia gas should not be allowed to rise during compression. This is the object sought by water-jacketing the compressor, and the efficiency of the water jacket can be readily observed from this curve in the indicator diagram. Also, the speed of the compressor very materially affects this line and hence the efficiency. If the compressor is operated too rapidly, the heat cannot escape from the gas to the water jacket fast enough and the curve becomes adiabatic and more work is done. A much more serious difficulty is encountered here owing to the fact that the entering cold gas on the next stroke rapidly reabsorbs this heat from the cylinder walls and expands back into the cooling coils before the valves are closed, and this results in a loss in refrigeration due to a diminution in the capacity of the condenser, since this effect is apparent in a change of density and temperature rather than of pressure, and the indicator diagram does not show it. An analogous effect is present in the steam engine, and it explains why increase in speed tends toward an increase in efficiency in the steam engine, whereas in the compressor the action is reversed. Thus, the indicator diagram becomes further an invaluable criterion in the regulation of the speed of the ammonia compressor so as to get the best results.

Of course, in practice, every ammonia compressor is run at its maximum operating speed in order to increase the capacity to its maximum irrespective of efficiency so as to decrease the relative value of the first-cost factor; but every operator should know the speed beyond which excess refrigeration can be produced only at a loss, even when all factors are considered, and this can be known only by deductions from the indicator diagram.

We have considered now only conditions in refrigeration similar to those in steam engineering—assuming a dry gas only in both cases, and not a condensable vapor or one containing liquid in minute particles, or with liquid in the cylinder. The consideration of these features materially alters the conditions to be considered and affects the form of the indicator diagram in a manner that is easily understood and recognizable. What has been stated is essentially true for the process known as "dry compression," in refrigeration. Now in "wet compression" a variable amount of liquid ammonia is drawn into the cylinder along with the suction. The first result of this operation is of course the fact that the cylinder volume available for gas to be compressed has been diminished by the volume of the liquid in the cylinder. The upper horizontal line in the indicator diagram is no longer proportional to the quantity of gas compressed in the cyl-

inder per stroke, if this is measured in volumes, as in the previous case with constant condensing pressure. The object of this injection of liquid into the compressor is the elimination of the reheating effect from the cylinder walls. This is not eliminated, however, but is present in both cases and is probably even more pronounced in wet compression. In dry compression, the capacity of the compressor may be cut as much as 20 per cent on account of this development. As has been said, this effect is present not as an increase in pressure due to the heating, but as a rise in temperature followed by a diminution in density at constant pressure and cannot be detected on the indicator card. In wet compression, a portion of the liquid is evaporated immediately on its entrance into the cylinder and the gas thus produced still further diminishes the available volume of the cylinder for gas coming from the cooling coils. However, the compression then occurs at a rather low temperature and with a much higher density for the compressed gas, and hence occurs with an increased quantity of gas. The extent to which these two opposing tendencies counterbalance each other is not known. The relative efficiency of wet and dry compression is still a matter of much debate and is not settled conclusively. If the water jacket, however, is not very efficient in its removal of the heat from the cylinder, in dry compression the effect becomes cumulative with increase in speed, whereas in wet compression this additive effect is not present and much higher speeds can be obtained theoretically if just the proper amount of liquid for cooling is injected with each stroke of the piston. The compression curve, even in the diagram for wet compression, is below the adiabatic and approximates an isothermal. Less work should be done per stroke by this method and the relative efficiency of the work in the two cases only is in question.

Now to consider the remainder of the diagrams in steam and refrigeration and their relative significance: this includes merely the lower limb of the cycle in both cases, and in steam work corresponds to the exhaust stroke and the return to the boiler pressure, while in refrigeration it consists of the suction part of the cycle and the effect of clearance on the lowering of the pressure in the cylinder to that in the cooling coils. In steam the area enclosed in the diagram must be as large as possible and this is assisted by having the lower line as far as possible from the upper line. This merely means that the exhaust pressure should be as low as possible for best efficiency. The lower line should be horizontal, because a rise means loss in area or a diminution of the available work. A slope in the line may be due to

a number of causes. The condenser may not have sufficient capacity, or the condensing water may be too hot for rapid work, and thus the advent of the additional steam may raise the pressure. It may mean also that the exhaust ports are too small, or the pipes too narrow, or that the valves are stiff or operating wrongly, and the form of this line combined with the remainder of the diagram enables the engineer to diagnose the particular difficulty with facility. The remainder of the line should be vertical and appear only at the end of the stroke when the pressure changes to boiler pressure again. Any variation from this vertical line means a loss in efficiency due to the slow motion or inertia of the valves, or to errors in the proper size of the ports and pipes, or to leakage at the valve seat during a part of the stroke, or possibly wrong time of closing the exhaust valves.

All these causes can be readily identified as variations and combinations of variations in the form of the diagram. In compression, on the other hand, the lower line involves in its vertical component the expansion of the gas which remains in the cylinder after the compression is finished and is known technically as the "clearance gas." Then follows the opening of the suction valve and the horizontal line of suction pressure. The greatest efficiency is obtained when this line is very close to the upper line, since then the area is smallest, or the work done is at a minimum. This result is obtained best with a high suction pressure, but this latter depends on the temperature of the boiling ammonia in the cooling coils; hence we see why the efficiency depends directly on the temperature which must be maintained in the refrigerator, and why the more extreme the refrigeration required, the less will be the efficiency of the process. The lower line should be horizontal. Any lowering of this line means increased work on account of stiff valves, insufficient ports or pipes, or an insufficient capacity in the cooling coils. The clearance line should be vertical and denotes then a complete absence of ammonia remaining in the cylinder from the compression stroke. If this line curves over it means abnormal clearance or leaky valves on the pressure side. Of course, less work is then done in a cycle since the enclosed area is smaller, but some of the work is always in this case repeated work and the efficiency is diminished. The effect of the clearance is simply the same as having a spring between piston and piston head. Work is lost here and is apparent as extra heat in both cases.

We have completed now the cycle of the indicator diagram in refrigeration. Its usefulness extends over a wide range and a large amount of knowledge thus becomes available in regard to the internal

behavior of the compressor and conditions governing its efficiency. Of course, the chief use of the indicator is in valve setting. A slight change in the position of the eccentric makes variations in the times of operation of the valves which very materially affect the efficiency. A complete study of valve mechanism and operation is not only possible with this diagram, but it constitutes the chief and best method for getting the best efficiency and proper operation in this department.

Whenever density and temperature enter as variables, often with variation in pressure or volume, the indicator fails to show significant changes in the form of the diagram. Operated in conjunction with thermometers (or rather thermometers and throttling carlorimeters) to get percentage of vapor or liquid in ammonia gas and temperatures, the combination is capable of giving nearly all the known or knowable facts about refrigeration and the action of compressors. Separated, each of these instruments is inadequate, but combined they are wholly sufficient. The use of indicators in refrigeration is a practice that should be encouraged, but their limitations without the thermometer should be recognized, and the limitations of the latter without the former should also be known.

THE IMPROVEMENT OF OPPORTUNITY FOR THE YOUNG WORKMAN.

By George Frederick Stratton.

The threatened difficulty of finding an adequate supply of skilled mechanics to carry on the engineering industries of the future has been repeatedly referred to in our pages. Dr. Bell's widely noticed article in our June issue pointed out that even now the conditions are beginning to show an unfavorable reflection in the American manufacturing trades. Mr. Stratton's hopeful suggestions have therefore a double interest, in that they bear upon a great subject and are based upon an intimate knowledge and trained observation of actual conditions.—THE EDITORS.

THE manager of a New England machine shop employing six hundred hands recently had occasion to engage a new foreman for one department, and he went outside and got his man. The reason given was that among the one hundred and twenty men in that department he was not able to select one who had the all-round knowledge required to handle the shop.

The tendency of manufacturers to combine and expand their factories into great plants has resulted in a specializing of mechanical work, which is far from conducive to any growth in manual skill or technical knowledge in the worker. Men start, in such shops, upon a certain machine or operation and, more or less speedily, become skillful at that particular work, with a result which can hardly be considered fortunate for themselves. They seldom or never get transferred to another operation as long as their work is satisfactory. They learn absolutely nothing but that one thing, and the steadier a man is—the more skillful and dextrous he becomes—the more surely is he doomed to a continual service in that one narrow rut.

A man in the shop mentioned above recently said to me: "I've drilled just so many holes in just that one part for four years, and I've never yet even seen the machine that part goes into!"

In a Massachusetts factory, where nearly two thousand machine-tool operatives are employed, not over three hundred have received general shop training. The others are young men who have learned no trade, but who can, and do, quickly become deft enough to feed material to some one machine, and feed it fast. The foreman of a gang of forty punch-press operatives, in this factory, lately said:

"There's not a man on the floor, as far as I know, who could carry the work along for a week if I got sick. Not one ever has a chance to show whether he has any executive ability or not. Every man has got to stick to his press and *pay no attention to anything else.*" In such shops the men are not expected, or even permitted, to acquaint themselves with their machines sufficiently to enable them to make repairs or adjustments. If anything goes wrong a man is sent in from the repair shop and the operator is laid off until his machine is again in working order.

Can the workman be blamed for this non-adaptability—this unpreparedness for exigency? "Pay no attention to anything else!" is the absolute root of the discipline in all highly organized shops. The man must visit no other department; he must visit no other machine in his own department. He must not "tinker round" with some idea of improving his own machine. He must produce, "from whistle to whistle," and think of nothing else—or at least do nothing else.

Nor are the managers to blame. They are engaged to manufacture goods at a profit. The educational development of workmen can by no means be entered on the annual report as an asset. Every machine must earn a dividend, and the man behind the machine who keeps its production up to the highest figure is the man who, although sure of a steady job, is just as sure of an inexorable detention at that one job.

There are two openings for men who have the character and determination to lift themselves from the ranks of "machine operators." The first is the apprentice course which, necessarily, is open only to very young men, or boys. Its recruits are largely determined by the opinions of the parents—which are, at the present time undoubtedly pessimistic. "What's the use"—is the consensus of expression—"of a young man's spending years to learn a trade—to become an all-round mechanic—when there are no jobs for such men? When a man can be taken off the street and put onto a lathe or planer, or one operation, and in two months earn as much money, piece work, as the fellow who has spent five or seven years at learning the trade?"

I want to emphasize that paragraph.

In a long experience with old mechanics I can unhesitatingly say that this is the very general feeling among them—that their boys stand no better chance, after a thorough, all-round machine-tool and bench experience, than after a three or six months' steady run on a jig-fitted multiple drill, or similar automatic tool.

That this view is incorrect and narrow there can be no question;

yet the men who express it and who really control the possible supply of future high-grade mechanics can hardly be blamed for their point of view. Nor are they usually in such positions, financially, as to be expected to sacrifice any portion of their incomes, or their sons' possible incomes, in the acquirement of an education which they doubt will be financially beneficial. The percentage of high-grade mechanics, in any highly organized machine shop, is very small compared to the "scrubs." The fathers see that. They form their opinions accordingly and sneer at the probability of any good chances for the first-class machinist.

Managers of thoroughly modern shops understand this feeling and, in most cases I think, appreciate it. They know, moreover, as the fathers cannot know, that there is a real, growing, and insistent need for the skillful, painstaking, old-time mechanic, whose prototype, as has been happily said, "was the foundation of our mechanical supremacy, but who is practically disappearing under the modern system." And to meet this need there has sprung up, during the past few years, a system of apprenticeship designed and fostered by the managers of great machine plants, so radically different from the old system as to well deserve a brief mention in this article.

Perhaps a description of the plan adopted (or rather devised) by the General Electric Company will demonstrate as clearly as any other system what is being attempted and accomplished in this new line.

Boys of from sixteen to eighteen years of age are received on this course, under a four years' agreement, receiving a nominal rate of pay at the start, with a stated, yearly increase, and also a yearly bonus for steadiness and efficiency. At the commencement they are placed in a shop which has been fitted up specially for apprentices, and they are under the control of a man who has been selected for his fitness as an instructor and discriminative disciplinarian. Here the young men get their first acquaintance with machine and bench tools. They work on regular production in simple lines—on turning small shafts and pulleys, and the accompanying boring, tapping, and fitting. Although this first step in handling apprentices has been in use for but three or four years the success of the plan has been most gratifying.

Instead of the old way of turning a green boy immediately into the shops—an unmitigated nuisance to a busy foreman and the butt of jocular misinformation from the men—the lad is first made familiar with shop tools, shop discipline, and to some extent with the system of shop orders and supply methods.

In from six to twelve months, according to his application and progress, he is transferred to one of the regular department shops and, although he is here directly under control of the department foreman, the apprentice foreman always has an eye upon him and he is really looked upon by the embryo workman as still his adviser and instructor. Transfers from one department to another occur after this as the developing intelligence and deftness of the man warrant. At the expiration of the course he has had ample opportunity to become familiar with every type of machine tool in the works, and his practice at the bench has been thorough. He has laid the foundation of skillful and comprehensive handicraft, and he can now make his choice of any one of the various departments, entering as a qualified and valued workman.

Systems similar to this have been, or are now being, introduced into most of the great manufacturing plants; but although the results are excellent to those who are able to take advantage of them, there remain a very great number of young men who have passed the age at which apprentices are taken on—men who have, as before mentioned, learned no trade, but who have worked on some one operation and know nothing else. If such a man is in a city where evening classes and manual-training schools are available he can improve himself as a workman; but something more is required to qualify him as a foreman, an engineer, or as a draughtsman who understands, as all draughtsmen should (but very many do not), the principles of the apparatus he is laying out. To a man who has these higher aims —who has the ambition and determination to lift himself above the condition of a mechanical drudge—the technical correspondence schools offer a rescue. They are easily available to men in any locality, no matter how remote, who would otherwise be unable to acquire the knowledge and receive the training they desire. They afford an opportunity of pursuing a course of study in a methodical and intelligent manner, and are especially helpful to those who would be unable to keep up with a class whose members have had better preparatory training than themselves. They are adapted to the needs of the workingman in that they assume no preliminary education on the part of the student. They employ experts in the line in which courses are to be given, who prepare complete courses of study, from arithmetic up to the most advanced subjects. Only such classes of mathematics are employed as are needed to utilize effectively the formulas and processes employed in actual work, it being deemed

necessary to simplify the course in this respect in order to meet the requirements of men who have only an hour or two a day for study.

Many men who are eminently qualified to judge of educational methods are unstinted in their praise of the "correspondence system."

The late Professor Harper of the University of Chicago has said:

> "It is a safe statement to make that the work done by correspondence is equal to the work done in class, and I may go even further and say that there is a larger proportion of high grade work done by correspondence than in the class-rooms. People take work by correspondence only because they wish to get something out of it, while many students come to class merely because they have to—because that particular course is required for a degree."

Dr. C. A. Murray, professor of pedagogy in the same university, is even more emphatic. He says:

> "Those who took a course by correspondence did three times as effective work and gained three times as much satisfaction for themselves as those who took it in the class-room."

Professor C. P. Steinmetz, president of the American Institute of Electrical Engineers, has expressed the following opinion:

> "What the man has seen, practically, in the work-shop, he will take up theoretically in the course, understand it, learn to calculate and control, and afterward, going back once more to the workshop, apply it. Here is where the average college graduate is inferior to the practical man and, in spite of his handicap regarding theoretical knowledge, the latter frequently rushes ahead of the college graduate by his superior understanding of the phenomena, based on his familiarity with them."

The subject of technical education for the workman has become a momentous question to the employer. Managers of great industrial enterprises are finding that the specializing conditions above mentioned are producing machine drudges only. Year by year and month by month it is becoming more difficult to secure men capable of assuming charge of shops—of attending to outside installations of machinery, or repairs on outside plants.

A railroad master mechanic recently remarked that, if he could, he would have every man in his employ take a correspondence course along the lines of his work. The vice-president of one of the great trunk lines has bought a number of courses for subordinates in the civil-engineering department of his road. A former president of the National Association of the Officials of Electric Light Companies states that the man in whose judgment in mechanical matters of greatest importance he puts most reliance, obtained his entire education in the practical work of the shop, with a correspondence course in electrical engineering to complete it. Mr. E. E. Boyer, chief of the

assembling and testing department of the General Electric Company's Lynn Plant (ten thousand hands), says that young men who have completed a correspondence technical course have been uniformly successful with him—that he has never known one of them to fall down. This finding of Mr. Boyer's is especially valuable when it is understood that from his department the company largely fills its ever-increasing demand for engineers, installation and repair experts, and salesmen.

The reason for this high commendation is not hard to find. Of all systems of education perhaps there is no other which so surely weeds out the weak and develops the strong. The qualities which go to make a man must be there to commence with. It is no light matter for a young man who has worked ten hours at machine or bench, to shut himself in his room every evening and study hard for two or three hours—usually alone, and without the incentive of competitive class work. Such work requires character—determination, self-denial, temperance, and a large capacity for steady application. If these qualities are present they will be greatly developed; if they are not present the man will drop out. In no human endeavor does the "survival of the fittest" more persistently and certainly occur.

A large proportion do abandon these courses, after having made a spasmodic start. Those who stay and finish have something even greater than their technical education. They have force, patience, self-control and splendid self-reliance. These qualities, backed by the theoretical knowledge of their work acquired on the course, and supplemented by their practical knowledge of shop discipline and practice, make men from whose ranks must inevitably come many of the great engineers and industrial managers whom the future will demand.

EDITORIAL COMMENT

IN one point, at least, the military superintendence of the Panama Canal construction is fulfilling our expectations and predictions. This is that the work has disappeared from the public eye. Whether it is going ill or well, it is at all events going silently. The storm of publicity which centered about the Isthmus some months ago has subsided into a great calm, stirred at rare intervals only by the slightest whisper of some brief message—so many yards excavated last month; such an one (civilian engineer) resigned.

Quiet and efficiency are often associated. In the interest of the Nation, may it prove to be so here!

* * *

ATTENTION may profitably be given to the code of engineering ethics which we reproduce on page 799 of this issue. While prepared by a committee of the American Institute of Electrical Engineers only for recommendation to that body, it was designedly framed to express the general principles of professional conduct, and therefore (as noted in our review) in almost all points applies equally to all branches of the engineering profession. It is inspiring to see these ideals so well conceived and expressed, and regrettable that formal difficulties or obstacles prevented the Institute from adopting the code. We are disposed to agree with some lay commentators in the feeling that it would be better even to amend a constitution than to allow it to stand in the way of the final adoption of formulated standards such as most of those this committee has framed.

A code need not be written, of course; it is, indeed, chiefly a compilation and restatement of principles already acknowledged and established. Their force lies in the inherent morality, not the mere legislative adoption. Nevertheless, ideas reduced to expression are far more influential upon many minds than ideas left in the abstract. Many and rigid rules are neither necessary nor desirable; they tend to loss of vitality and stagnation. Indeed, there is danger that strictly professional tenets may be confused with ethical principles and so crystallized in codification that they will actually hamper free development; and there is, on the other hand, danger that through inadequacy of substance or expression, great truths will be but partially stated, thus leaving room for some to err or offend in spirit while keeping within the letter of the code. The proposed system may not be wholly free from one or other of these objections—but this is a matter of detail and of adjustment. The public recognition of a high system of ethics is in every way helpful. An instance and a precedent may be found in the Hippocratic oath taken by every initiate into the practice of medicine. Is there any doubt that the profession is the better, the cleaner, and the more beneficent to the world through the express adhesion of its members to this formula?

In these days of low industrial morality and dubious business methods, especially, it is well to assert and reassert that the professions are under a higher law and must conform to higher standards. Duty to the interests of the client should be held constantly before the professional man as the great obligation which his profession imposes upon him—yet, great as it is, sometimes subordinate to his duty to the profession itself. When this conflict occurs—when, so to speak, the client seeks the commission of malpractice—the engineer must withdraw. Not the least significant part of the code is

its indication of the circumstances amid which this action will be demanded. It is well for the laity, as well as for the profession, to be clearly advised of the possibilities of such a situation arising, and of the course which it will certainly necessitate.

* * *

THROUGHOUT the East, certainly, if not more widely over the country, there is very general complaint on the part of railway superintendents and maintenance-of-way engineers that good section hands are almost a thing of the past. Men cannot be secured to work under the old methods, and rapid change is in progress toward a system of track repair and maintenance by large gangs, moved from place to place on a work train upon which they eat and sleep. One would suppose that the conditions of life would be pleasanter for a section man living in his own home, near to his job, free to spend the hours of rest with his family; yet the section gangs, formerly recruited from a class living thus, cannot be kept full, and the herded Italians of the work train are installed as substitute.

To the sociologist this might present a curious phenomenon—not altogether encouraging — analogous, perhaps, to others appearing in certain cases of centralization of population and of industry. From the track point of view it is very unfortunate. Not only the system of minute inspection and continuous repair, but the spirit of emulation between various sections, will die out with the disappearance of the former working units and of the sense of individual identification with definite parts of the work. And, as in many departments of the mechanical trades, the loss of the older training means the loss of the kind of men who made the new order possible. It is said to be already very difficult, and increasingly hard, to find competent men for section foremen. All these things have a direct bearing on the much mooted question of safety in railway travel.

A WRITER in a British daily recently, criticizing the methods of the Rand mining companies, gives utterance to some sound remarks on the tendencies of elaborate systems to become rigid and out of touch with changing circumstances. Although intended for the specific case of the South African mines, the following passage provides an eloquent warning which might be heeded by all industrial concerns in which a central administration is entrusted with the direction of a complicated and widespread business:

> "A vast organization imposes a heavy burden on those who direct it from the centre, and the temptation is always present to relieve the strain by clinging to rules too rigid for the facts, or obsolete because the facts have changed. The only safeguard against the tendency of a great system to stiffen and become muscle-bound is periodic revision by able and independent minds not previously identified with its organizations. Constitutional Government to some extent supplies this need by placing the great offices in charge of laymen and by changing them from time to time. It provides relays of new brooms. Even so, a Civil Service Commission is required from time to time to review and refresh the whole organization. The presence of these two influences accounts in great measure for the difference between an English and Russian Civil Service. Now that business and industry are being organized in larger units every year, the world is beginning to realize that great industrial organizations may outgrow their hides, no less than Government Departments."

Notwithstanding the considerable attention that has been given of late years to problems of organization, it is to be feared that many persons have not yet realized that reorganization is not a finite operation at all, but a continued process. Few businesses work under the same set of circumstances from decade to decade, and it cannot be too clearly understood that the best of systems becomes actually harmfu

when it no longer corresponds to the conditions of the moment. In other words, the internal life of a large business is just like the internal life of any other organism. It grows and decays, and even when it is doing neither of these it is constantly undergoing change in its external relations. What has come to be termed "reorganization" is therefore a book of which we can never come to the last page, and this is so even without taking into account the constant improvements in methods of organization, which is perhaps as progressive a branch of knowledge as the technical side of manufacture. There is the less excuse for allowing an organization to become obsolete, in that, commonly, no capital to speak of is locked up by the adoption of any particular method. Unlike heavy machinery or particular systems of transmitting power, the materials and appliances for any reasonable system of organization are comparatively inexpensive, and bear very small relation to the great economies which may be effected from time to time by making the system correspond more closely to the actual working conditions. The principal danger of elaborate systems is that they make the work of subsequent modification more difficult than it should be.

* * *

THE President's very far-reaching proposition concerning the extension of employers' liability, and the "automatic" process for the recovery of damages by injured workmen, seems to have received less comment than might have been expected in the industrial press. Possibly the reason lies in the general acceptance of the belief that any legislation directed to such results must be State rather than Federal, and that even the most energetic utterance from the Chief Executive of the Nation therefore is but a suggestion. Nevertheless, it is certain that the movement of the future will be in the direction pointed out by Mr. Roosevelt, if not at the rate nor to the distance he indicates. The tendency of judicial decisions, the drift of public opinion, and the experience of the older countries all afford strong evidence of this.

Our present waste of life and limb, in constructive work, mining, manufacturing, and transportation, is appalling. When all allowances have been made for the recklessness of employees, there remains a heavy charge against us as a nation of employers. We seem still to hold, perhaps unconsciously, some of that low estimate of the value of life which belongs to new countries. In the haste to do, and to do quickly and cheaply what has to be done, we give too little thought to safety and are too little impressed by accident, especially as the penalty is generally paid by someone else. Severe liability laws are designed to bring back that penalty to the interest responsible for the entire control of both undertaking and methods.

In fact, they do better than this. The risk placed upon employers is at once shifted to insurers. Here as elsewhere, these are rising and will increasingly rise to the demands of the situation and in large measure control the conditions they are called upon to insure. Fire and marine risks have been immensely improved by the careful study, regulation, and inspection established by the underwriters. Accident risks will follow the same course. Not only will the inevitable proportion of loss be distributed over industry at large, but this proportion will be reduced to a minimum through the watchfulness and oversight of the liability companies. We shall save hands, limbs, and lives instead of paying for them, and that which was designed as a remedy will become, to the largest possible extent, a preventive.

REVIEW OF THE ENGINEERING PRESS.
"THE WORLD IS ITS FIELD"

STANDARDIZATION AND LABOR EFFICIENCY IN RAILROAD SHOPS

THE METHOD OF EXACT MEASUREMENT APPLIED TO INDIVIDUAL AND SHOP EFFICIENCY AT THE TOPEKA SHOPS OF THE SANTA FE.

Harrington Emerson—American Engineer and Railroad Journal.

THE Santa Fe has taken a leading place in the application of standardization and systematization to the efficient and economical management of railway shops, on the principles laid down in Mr. H. W. Jacobs' notable series of articles in recent numbers of THE ENGINEERING MAGAZINE. Economy and efficiency of labor have been studied in great detail and the remarkable results obtained at the Topeka shops form the subject of an interesting paper by Mr. Harrington Emerson in a recent number of the *American Engineer and Railroad Journal.* The paper is interesting also in offering a concrete example of the benefits to be derived from standardization, as described in an article on the economical utilization of labor reviewed in these columns last month. Mr. Emerson's article gives many tables and examples which it is impossible to reproduce, the following extracts giving only an outline of the methods employed and the results obtained.

"Shop efficiency pays. By shop efficiency is meant a careful investigation and betterment of all conditions, so that with the same effort men can accomplish more. To secure the co-operation of the worker with the management in cutting out unnecessary wastes at the Topeka shops of the Atchison, Topeka & Santa Fe Railway, he is offered an increase of as much as 20 per cent. If by means of special strength or skill he does more work than normal he is given *all* the gain, for instance, if he does in one hour a job standardized at two hours he receives two hours' pay for an hour's time. The management gains, firstly, by the elimination of unnecessary wastes, although it gives the worker a 20 per cent. increase, and it particularly gains by the increased efficiency of its machines and other equipment, which results in a larger output without the necessity of increasing the capital investment. The actual results at the end of two years of systematically organizing the Topeka shops on an *efficiency* basis were:

To increase the average pay of the men 14.5%
To decrease the unit cost of production 36.3%
To increase the shop output..... 57%

"There is no reason why all the men should not earn at least a 25 per cent. increase above standard wages, and many of them do, 40 per cent. of them earning a 25 per cent. increase and better. The average efficiency of all the men in the month of April, 1907, was 94.2 per cent. Two years ago it was about 60 per cent. Although the average of all the workers is 94.2 per cent. there are many who are better, many who are not as good. One man earned 105.4 per cent. above standard wages. Four men drawing full pay were 64.7 per cent. below normal, doing only one-third of what they should have done. These figures are not guessed at, but taken from the actual operations of this large locomotive repair shop in which every job

is standardized and the efficiency of every man determined. Now, the system is perfected and it costs no more to keep it in operation than the former barren methods. The successive steps of progress were:

1. A permanent and standard *method* for determining costs of every operation.
2. The betterment of all conditions.
3. The determination of a standard cost of *every* operation.
4. A comparison of actual costs with standard costs as to every operation.
5. The guarantee to each individual worker of standard wages, and the payment of an added amount based not on the piece or on output, but on efficiency.
6. A check and reward of each foreman on the basis of the efficiency of those under him.
7. A check of the efficiency of the shop as a whole from month to month.
8. The use in all accounting, of *standard costs,* not *accidental* actual costs.

A brief outline of the successive steps follows:

"Costs are of two kinds, those that can be located and those that cannot be located. The work of a machinist and also of his machine can be located. The problem of cost determination reduces itself into apportioning to each man and each machine, the indirect or unlocated costs in addition to the direct or located costs. To do this, each item of indirect cost is apportioned either to men or to machines or partly to one and partly to the other. Having thus secured two grand totals, one of indirect men costs and the other of machine costs, the totals are subdivided to various departments. Whereas the indirect cost as a whole may be 75 per cent. of the pay roll, within the confines of a department, the percentage may vary from 15 per cent. up to 400 per cent., showing how absolutely inaccurate the usual method is of applying the same flat rate of factor, surcharge or burden to all departments alike.

"Having secured substantial accuracy by apportioning each class of costs, men-costs and machine-costs, to each department, no great errors can arise in any particular method of subdividing departmental charges to specific men and machines. The simplest method is therefore preferable. The method adopted at Topeka was to assess indirect men-costs as a percentage on applied labor, to assess all direct and indirect machine costs as a yearly charge on the inventory value of the machines. To ascertain the hourly rate for each machine, the yearly charge to the machine was divided by 2,400 hours, it being assumed that the machine worked 80 per cent. of the time. If there were any gains in simplicity to be effected by modifying this general method within the boundaries of a department there was no hesitation in allowing common sense to govern. For instance, when it was discovered that a direct worker on a shear did 200 different small jobs a day, he was at once considered an indirect worker, and when a machine rate worked out at $0.01 an hour, the machine was promptly relegated to the list of indirect machines. There is no sense in an accuracy that makes the distribution of cost amount to more than the cost itself.

"Power is determined at so much per horse power and floor space at so much per square foot for the plant as a whole and charged on a flat basis to each department. If one department is further from the power house than another and therefore suffers a greater line drop loss, this loss is considered a plant loss, not a department loss, and it is borne in the form of a general increase in power cost. What would one think of a gas or water company which charged more for gas or water because the customer was farther from the central plant or which charged repairs of mains to the customers served by the mains, yet just this kind of cost accounting has brought the whole art of factory cost accounting into deserved disrepute!

"With a machine rate, man rate, and man surcharge provided, and time known, the cost of every operation is at once determinable. . . . . .

"The betterment of all conditions was a very large task and involved everything that could be done to improve machines, tools, operation and general comfort of the men, as, for instance, better lighting and heating. It is evident that standard costs could not be determined until conditions were in the main standardized.

"The determination of standard costs was most completely and conscientiously carried out. The motto adopted and pro-

mulgated by the authorities in a pamphlet distributed to the men was:

'Fairness, not Favoritism.
Individuality, not Subserviency.
Efficiency, not Drudgery.'

"A time study of a job under actual working conditions by the regular worker was made by a practical man, a machinist, a boiler-maker, or a blacksmith, as the case might be. The machines and other conditions, tools, belting, speed, etc., were first adjusted. It made no difference whether the job under observation actually took a long or a short time. It was the duty of the observer to set down a reasonable and proper time. As a rule the times eliminated from standard were not those of reasonable work, but those of unnecessary waste.

"The comparison of actual costs with standard costs as to every operation is exceedingly easy. Each job is assigned to each man on a work card which states the standard time. The man notes his own actual time which in the aggregate must check with his clock time. The efficiency of each man is tabulated each month and the efficiency reward is on a sliding scale. It begins at 67 per cent. and increases rapidly according to a table carried out to tenths of a per cent.

"The efficiency of the foreman depends on the efficiency of all the men under him. If all the men average 100 per cent. the foreman receives 20 per cent. increase on his own wages. Under some other foreman the extra earnings of the men might be in the aggregate more, but not average as well, if some men were very good and others very poor. Such a foreman would earn less increase, so it is to the advantage of a foreman to bring up his whole force evenly."

Mr. Emerson shows two diagrams of monthly records of shop efficiency, the abscissæ of the points on the curves representing percentages of efficiency, and the ordinates, percentages of time worked at the efficiencies shown. On these a vertical line shows the average efficiency for the month. Commenting on these records Mr. Emerson says:

"Shop efficiency as a whole is determined by the average efficiency of all the workers. The two diagrams show the same shop in two successive months and the improvement in the second month is largely due to the lessons in the diagram of the first month. It is plain that the shop is improving when the average efficiency line moves to the right, that it is retrograding when it moves to the left. It can be made to move to the right by finding out what the matter is with the men whose average efficiency is low, and all workers with an efficiency under 70 per cent. should be investigated. The record is there not only as to monthly efficiency, as a whole, but as to every single job done in the month. It often happens that efficiency falls through no fault of the worker, as when a steel casting is so hard as to make normal work impossible. In very marked cases of this kind temporary schedules are put into effect to suit the peculiar and exceptional occurrence.

"Since every job is standardized it necessarily has a standard cost. How ridiculous it would be for a railroad company to attempt to vary its ticket prices on account of accidental delays or extraordinary expenses, as for a wreck.

"It is not less ridiculous to attempt to follow into costs accidental variations of shop operation. If a fast worker is on a job one day and a slow worker on the same job the next day, both have varied from standard, but the selling price of what they have made has not changed.

"Variations from standard costs are accidents of shop operation and are to be taken care of, not in detail but as a whole, by a factor added in the office. In the examples of the two months, the efficiency of labor was 89.5 in March. Actual labor costs were therefore 11.7 per cent. higher than standard. This 11.7 per cent. could have been applied to each item of the output in the following month. In April the actual costs were 6.2 above standard, so for May 6.2 per cent. could have been added to the direct labor part. The discrepancies should, however, be averaged for at least twelve months, and if this was done it would be found that the fluctuation in office factor to be thrown forward with the succeeding month would not vary as much as 1 per cent. from month to month.

"The effects of this system of shop management are:

(1) To increase output enormously without adding to shop equipment or space.

(2) To reduce unit costs as much as 30 per cent. or more.

(3) To increase the pay of the best men as much as 30 per cent. on the average.

(4) To hold permanently the best men.

(5) To know accurately the cost of every item before work is begun on it.

"The system is equally applicable to railroad operations as a whole, *i. e.*, the mileage of engines and cars and tonnage movement. It is, in fact, on the Santa Fe now being adapted to determine the efficiency of each engine, exactly as in the Topeka shop it has been perfected to determine the efficiency of each man. Even as men in average shops work with less than 60 per cent. efficiency, so also do engines work with less than the 60 per cent. efficiency. What was done with the men in the shop can be done with engines."

A RAILROAD APPRENTICESHIP SYSTEM.

AN OUTLINE OF THE APPRENTICESHIP SYSTEM RECENTLY INTRODUCED ON THE NEW YORK CENTRAL LINES.

C. W. Cross and W. B. Russell—Railway Master Mechanics' Association.

THE scarcity of skilled workmen, which has led to the recent revival on an extensive scale of the apprenticeship system, is nowhere a more serious problem than in the motive power departments of the railroads. The recent inauguration of an apprenticeship system on a large scale in the shops of the New York Central Railroad is important, not only as an example of what may be done in manufacturing and commercial organizations, but as indicating a development in railroad management which promises to be far-reaching in its results. The following outline of the New York Central system is taken from a paper by C. W. Cross and W. B. Russell which was one of the most interesting presented at the recent annual convention of the American Railway Master Mechanics' Association.

"The purpose of the apprentice system is to provide the Motive Power Department with an adequate recruiting system which will eventually produce from the ranks a large number of skilled workmen, a number of foremen, a sufficient number of good draftsmen, a few Master Mechanics and an occasional Superintendent of Motive Power. The general plan is twofold, and provides for shop instruction of the apprentice in the trades and also for his instruction in mechanical drawing, practical mathematics and shop problems during working hours while under pay.

"A Department Headquarters was first organized to outline the courses of instruction and to prepare the necessary instruction sheets and text-books. Two instructors—a shop instructor and a drawing instructor—were then appointed at each of the larger shops; a uniform set of apprentice regulations was adopted for all shops and a schedule provided showing the time allotted in the shop to each class of work. This schedule is sufficiently flexible to insure a prompt movement of the apprentices from one type of work to another and still to leave opportunity for rapid movement in case of special merit. Both the shop instructors and the drawing instructors are under the local shop officers and responsible directly to them. Regular reports are made by both instructors to their immediate superiors, who forward them to the apprentice headquarters. In the educational work, however, the instructors are kept in direct touch with the Apprentice Department.

"The plan is now in operation at nine of the largest shops of the system, and includes about 450 apprentices. The work is gradually being extended to the smaller shops. The drawing instructor in every instance is a draftsman or mechanical engineer, located either at the shop or a company drafting room close at hand. The shop instructor in most instances holds some other position in the shop in addition to that of apprentice instructor. The apprentices are under the foreman, and responsible to him as formerly, but the foreman is relieved of the duty of instructing them, thus enabling him to give his full time to directing the work of his department.

"The work in drawing and shop problems is outlined at the apprenticeship headquarters at New York city, and sufficient flexibility is allowed to fit the personality of the local instructor and the needs of the local apprentices. The plan of instruction is arranged to give the closest possible connection between the work in the shop and the work in the classroom. Subjects are not classified as in most school systems, but the necessary mathematics, mechanics, physics, and chemistry are introduced only as needed to solve some practical shop problem. The drawing is from actual parts from the start, omitting all exercises and geometrical work as such, and introducing principles only as needed to gain practical ends. Simple blue-print sketches are used for the drawings in connection with the actual machine parts; printed sheets are supplied for the problems. The shop instructors co-operate with the drawing instructors in looking after the general welfare of the boys. Arrangements are made for the instructors to make occasional visits to other shops to observe methods of instruction. Apprentices are sent to visit other shops and report their observations.

"The instruction is largely individual, with classes limited to twenty-four apprentices at one time. By use of the blueprint sketches on which are the necessary directions, it is possible for the instructor to hand an apprentice a sketch and a machine part, thus enabling the apprentice to start at once on the work. This method permits the instructor to keep a class of twenty-four busy, even when each member is working on a different sheet. The first drawings are very simple, so that accuracy may be insisted upon from the start. In order to save time and have corrections made at once, no work is removed from the drawing-board until it receives the instructor's O. K. The work is scaled so that it can not be copied from the sketch and the course is arranged to advance more slowly than usual drawing courses. One principle is introduced at a time, and then only as needed to make an actual car or locomotive drawing. Lettering is an incidental item. The shop problems are usually worked at home on standard sheets, and an occasional blackboard review is given in class. The home work is assigned on loose printed sheets which makes it possible for an apprentice to go as rapidly as he desires. In the courses that are now used, much that is dear to the mathematician and physicist has been left out. All the work that is introduced is in accordance with the New York Central Lines practice, from which illustrations are selected. A comprehensive system of reports is made by both instructors to the local shop officers. These reports show: First, the ability at the trade; second, the disposition and personality of the apprentice, and, third, the standing in class work. The instructors are at all times required to know the standing of each apprentice, thus making examinations unnecessary. Special emphasis is placed on the personal touch maintained between the instructor and the apprentice, with a view to determining the type of work or branch of service for which the boy is best fitted. It has been found necessary to use great care in selecting instructors, who must be men who are not only competent, but who are willing to undertake the work for the love of it and their interest in the young men, as well as for the remuneration they receive. At the expiration of apprenticeship, those who have satisfactorily completed their term receive certificates which entitle them to preference in employment at all shops on the New York Central Lines.

"Instruction is given each apprentice four hours a week during shop time; that is, two mornings from 7 to 9 o'clock, and such instruction is all classed under the name of mechanical drawing. Apprentices ring in before coming to class and are under shop discipline during the session. At 9 o'clock they proceed directly to the shop. Home work is expected on the problems. Both instructors are available for consultation during the noon hour.

"No more interesting study has presented itself than the personality of the average apprentice. On the whole he is below the standard of education and ambition generally presumed by most motive power officers, who naturally think all apprentices possess the same exceptional initiative and earnest endeavor which has brought them up from the ranks. The average apprentice possesses a great deal of human nature; he means well, intends

to make the most of his opportunity, generally prefers to be a real boy and to enjoy life, rather than to work problems at home; he will not read a text-book except under compulsion, and has absorbed a little of the idea that the easiest way to become a journeyman is to do as little work as possible. On the whole, however, the interest of the apprentice is good, and is increasing in proportion as the facilities for experimental work are increased and the plan of instruction is extended. There are instances where the boys have kept the local instructors busy in supplying them with work, and it is evident that the ambition of many boys has been aroused and that the right chord has been struck, so that in time the boy without ambition will become a rare article. Reports show that apprentices started during the last year have evidenced a most commendable enthusiasm. It might also be interesting to state that at nearly all points there are advanced apprentices who take full charge of classes when the instructors are absent.

"The effect upon the apprentices has already awakened interest and marked improvement in skill in the shop, ability to read drawings, ability to lay out templates, and in several cases skill in drafting sufficient to warrant assignment to the drafting room for sixty-day intervals.

"Perhaps as vital as any other principle is the necessity for caring for graduates with infinite pains after they have completed their apprenticeship terms. The results of the best possible apprentice system may be absolutely nullified if the organization into which the graduates are to go is not properly prepared to receive them. It is not too much to say that most railroads and most industrial establishments need to put their organization in such order as will render not only employment desirable, but advancement possible. As an incentive to all and a reward to the especailly studious and proficient, it is desirable to give a limited number of those showing the best records a prize in the way of a more advanced course at a technical school at the expense of the railroad, the young man to work in the shops during vacation time, thus retaining his close relationship to the work.

"It will undoubtedly take years to show the full value of the apprentice system. Already draftsmen are being provided for the Company drafting rooms, and New York Central standards are becoming familiar to all apprentices. In the future every journeyman will be able to read drawings and make working sketches. Men will show greater pride in their local shop and increased loyalty to the Company, and the tendency to resign their positions for work with other companies will be lessened. It is not expected that all of the boys will attain a degree of efficiency that will qualify them for leadership, or that all workmen will possess the same measure of ability and activity, on account of the difference in their natural intellectual and physical qualifications, but it is expected that each will be developed to a high degree in his particular line, with the result that eventually each shop will be manned by a force of mechanics embodying an advanced state of proficiency from which at least a few competent men may be had at all times for positions of leadership."

GAS PRODUCERS FOR PULVERIZED FUEL.

A DESCRIPTION OF A GAS PRODUCER RECENTLY DEVELOPED IN FRANCE WHICH UTILIZES ALL GRADES AND KINDS OF COAL WITH EQUAL FACILITY.

Le Génie Civil.

ACCORDING to a recent number of *Le Génie Civil* the problem of utilizing all grades of coal in the gas producer has been satisfactorily solved in France by the invention of M. Marconnet of a producer into which the fuel is introduced in a finely divided condition. The following abstract gives a description of the producer and the advantages claimed for it.

M. Marconnet has succeeded in developing a gas producer which utilizes with equal facility fuels entirely free from volatile constituents, such as coke dust, and fuels in which the proportion of volatile matter reaches as high as 30 to 35 per cent.

Further, the percentage of ash is a matter of indifference, the producer working equally well with fuels containing 5 or 30 per cent. of incombustible matter, and good results have been obtained with even bituminous shales containing 70 per cent. of ash. Finally, not the least important advantage possessed by this producer is the fact that it is able to utilize the fine coal and slack which ordinarily goes to waste in coal-mining and washing operations. These results are attained by charging the producer continuously with pulverized fuel, thus avoiding all the difficulties encountered in the ordinary type of producer with its intermittent charging of lump coal.

The use of pulverized fuel makes grinding necessary. This is done usually in tube mills, the cost under ordinary conditions being from 1¼ to 2 francs per ton. The fuel is introduced into the producer by means of an apparatus which resembles in principle the carbureter of a gasolene motor: that is, the air drawn into the producer carries with it the pulverized fuel with which it becomes thoroughly mixed before it enters the producer proper.

The producer proper is cylindrical in form and is lined with some sort of refractory material. The mixture of air and coal dust enters at the bottom of the cylinder and tangentially to its circumference. Combustion is set up in the first place by the introduction into the producer of a few pieces of burning wood, the admission of air and fuel being cut down to convenient proportions. The temperature rises rapidly and full working conditions are attained in a very short time. The incombustible materials are projected by centrifugal force to the walls of the producer where they collect in small liquid globules and finally run down into a slag at the bottom. This slag is tapped off every six or eight hours through a tap hole similar to that of a cupola, an arrangement which gives every satisfaction. This slag varies in appearance with different kinds of coal. It is very rare to find a coal of which the incombustible constituents will not settle in this manner, and such difficulties can generally be removed either in the grinding or in the charging of the fuel.

"To obtain regular working of the apparatus, it is of prime importance that the proportions of air and of coal should be capable of exact regulation and maintenance at all rates of working; in other words, that the charging device should have a simple and efficient regulating mechanism. M. Marconnet has achieved this result in the following manner:

"The pulverized fuel is charged into a hopper whence it falls by gravity on to a horizontal revolving plate placed about one centimetre below the hopper. This plate is revolved by means of a friction roller, working on its under side, the distance of which from the axis of the plate can be regulated during working. During the rotation of the plate the fuel is met by a scraper placed obliquely, which causes the coal to fall in a thin stream on a second plate which may be adjusted at any angle to the horizontal. In sliding off this latter plate, the pulverized fuel passes the intake of a fan which supplies air to the producer and is drawn in along with the air, the mixing process being complete.

"Since the rate of working of the producer varies with the speed of the fan, and the speed of rotation of the feed plate depends directly on the speed at which the fan is driven, the supply of coal varies automatically with the air supply. Further regulation of the fuel supply may be obtained by changing the position of the friction roller, raising or lowering the rotating plate to increase or lessen the flow of coal from the hopper, altering the position of the scraper, or changng the angle of inclination of the adjustable plate. In the latter case, changing the angle of inclination of the plate alters the distance of the falling stream of coal from the intake of the fan. By this means the fineness of the coal supplied to the producer can be regulated as the size of the lump that can be drawn in by the current of air depends upon the distance of the stream of fuel from the fan intake. A receptacle is provided into which the larger particles, unaffected by the air current, fall, whence they are returned to the tube mill for further grinding."

A 600 horse power unit has already been constructed on this system and put in successful operation. This producer occupied a space 1.8 by 3 metres and was 3 metres in height.

The high temperature produced at the moment of combustion and the thorough mixing of the gases by their rotary movement in the producer has the effect of completely breaking up the heavy hydrocarbons into gaseous products of simple chemical composition. After eighteen months of operation with coals containing 30 to 35 per cent. of volatile matter no trace of tarry products has been found. The absence of tar makes the cleaning of the gas an easy matter as it is necessary only to cool it and to remove any dust which may be carried over.

THE UTILITY OF INVENTIONS.

THE MEANING OF UTILITY AS PREDICATED OF INVENTIONS IN THE PATENT LAWS OF THE UNITED STATES.

John E. Brady—Electrical World.

THE relation of patents to the manufacturing industry was very fully treated in Mr. Prindle's series of articles in recent numbers of THE ENGINEERING MAGAZINE. In connection with this series the following extracts from an article by Mr. John E. Brady in a recent number of the *Electrical World* are interesting as showing the extent to which an invention must be of public utility before it is patentable.

"Utility, as predicated of inventions, means industrial value; the capability of being so applied in practical affairs as to prove advantageous in the ordinary pursuits of life, or to add to the enjoyment of mankind. But a mere curiosity, a scientific process exciting wonder, yet not producing physical results, or any frivolous or trifling article or operation not aiding in the progress nor increasing the possessions of the human race, whatever be its novelty, and whatever skill has been evolved in its production does not fall within the class of useful inventions nor become the subject matter of a patent. It has been said that the test whether an invention is useful in the sense of the patent law is not whether it is not mischievous or hurtful, or insignificant, but whether it is capable of use for a purpose from which some advantage can be derived. If it be useful in this sense the degree or extent of its usefulness is altogether immaterial. It is not necessary that it should be the best means of producing a desirable result, but a means, although inferior to others, of producing it.

"Inventions which accomplish definite practical results may nevertheless possess such attributes as destroy the benefits that otherwise they would bestow upon the public. Inventions whose chief or only value resides in the facilities which they afford to men to perpetrate some wrongful injury either by fraud or violence upon each other, are thus regarded as destitute of real utility. For the same reason arts or instruments which, if completed and in actual use, might be of benefit to their employers, are sometimes held to be devoid of real utility on account of the great risks incurred in their construction. The courts, in their consideration of this subject, must necessarily contemplate the entire scope and effect of the invention, as well upon the maker and operator as upon the consumer; and if the net result to the community at large is not a benefit, the inventor has no claim upon the public.

"The acts of Congress which authorize the grant of patents for designs, were plainly intended to give encouragement to the decorative arts. They contemplate not so much utility as appearance. The law manifestly recognizes that giving certain new and original appearances to a manufactured article may enlarge the demand for it, may enhance its salable value, and may be a meritorious service to the public. It, therefore, proposes to secure for a limited time to the producer of those appearances the advantages flowing from them. Utility is not negatived by the fact that the manufacture covered by the patent has no function except to decorate the object to which it is designed to be attached. In such cases utility resides in beauty. Whatever is beautiful is useful, because beauty gives pleasure, and pleasure is a kind of happiness, and happiness is the ultimate object of the use of all things. The

Westinghouse Electric & Manufacturing Company, being the owner of a design patent issued March 22, 1902, to Albert Schmid, brought an action against the Triumph Electric Company, seeking to enjoin the latter from infringing its alleged rights under the patent. The patent involved covered a design for a configuration of a frame for electrical machines. It was held that the word 'useful' in the section regulating the issue of design patents does not require that the shape or configuration of an article, in order to be patentable, shall add some new utility to the article, but is used merely for the purpose of excluding such things as might have a vicious or corrupting tendency, and that a new and original design for an article may be patentable where it merely improves its appearance. But it was further held that, assuming that a frame for an electric machine might be made the subject of a design patent, the frame design in question was not properly patentable for the reason that it was neither new nor original in view of the existing state of the art. The only originality which the counsel for the complainant could reasonably claim for the design patented was found in the curvature of the bases of the pillars for supporting the shaft and of the supports to the cylinder frame for the field; and these were considered differences which would suggest themselves to any workman, and which did not involve the exercise of inventive genius, which is as essential to the validity of a design patent as it is to the validity of a mechanical patent.

"It seems that utility is negatived if the function performed by the invention is injurious to the morals, the health or the good order of society. Thus, an invention to improve the art of forgery, or one to facilitate the spread of a contagious disease, or one to render water or air intoxicating would, of course, be unpatentable for want of utility. The more completely such an invention could perform its function the more objectionable it would be in this respect. In the case of National Automatic Device Company vs. Lloyd, the complainant moved for an injunction restraining the infringement of a patent for a 'Toy Automatic Race Course.' The device covered by the patent consisted of a shaft projecting upward from the center of the base of a circular shell or case, to which shaft a clock-work mechanism was so geared that it could be made to revolve rapidly by releasing the escapement of the clock-work. On the shaft were mounted two or more radial arms, to the ends of which were attached small toy figures of horses. The clock-work was released by dropping a coin through a slot in the machine, whereupon the shaft would revolve, carrying the radial arms with it, for a short time, when the clock-work would be shut off allowing the arms to revolve of their own momentum. The proof showed that the only use to which the device had been put was to install it in saloons and other drinking places, where the frequenters thereof might lay bets as to which toy horse would be the last to stop or would stop nearest a certain designated point; in other words, the machine was used only for gambling purposes. For this reason the machine was held not to be a benefit to society or 'useful' within the contemplation of the patent act and the patent was declared void. It was urged that the machine was susceptible of being utilized as a toy or child's plaything, but the fact that no such use of it had been made was considered a sufficient answer to that contention.

"Inventions the object of which is to afford amusement and diversion, are classed among patentable subjects; but only the mechanical agencies employed can be patented. Under this rule it was held that the patent of the Paul Boynton Company, covering an inclined gravity railroad terminating in a body of water which provided an amusement popularly known as 'Shooting the Chutes,' was invalid, one of the reasons being that, in view of the old art of launching ships, there was no patentable novelty in the combination of an inclined railway located near a body of water and a boat-shaped car or toboggan, adapted to move downward over the railway and to be propelled forwardly upon the water by the momentum derived from its descent.

"In the Cushman case, an electrical patent was refused on the ground of the absence of utility and an appeal was taken from the decision of the Commissioner in so refusing. The device for which a patent

was sought consisted of an improved method for protecting objects from the effects of lightning by surrounding that part of the lightning rod which is embedded in the earth with a galvanic battery. Its construction and functions were described by the inventor in the following language: 'To facilitate the discharge of the electricity from the conductor to the earth is the object of my present invention, and it consists in surrounding that part of the lightning rod embedded in the earth with plates of dissimilar metals, arranged in such a manner as to constitute an open galvanic battery. Electromotive power will divide the electricity on the metallic plates and, as they are insulated, they will act as a condenser of the electricity that is opposite to that of the air. Should there be a high electrical tension of the air, by this means the electrical fluid conducted through the rod is more readily discharged by uniting with the opposite electricity as it accumulates on the surface of the plates. When the discharge flows from the earth to the air, then the rod conducts from the plates such electricity as is opposite to that of the air.' The reason which the Commissioner gave for refusing a patent was that the intensity of the action arising from either the copper or the zinc plate, or both, in the earth, is thousands of times too small to be sensible as compared with that of a flash of lightning. 'The latter has force enough to strike through hundreds or thousands of feet, or sometimes through miles of air. The former has not force enough to strike through the thousandth part of an inch. These are well known facts and the thing must be entirely without practical effect.' The court was satisfied that the device in question could be put to no beneficial use and the Commissioner's refusal was affirmed.

"The degree of utility is not material and a patent may rightfully issue, so far as that quality is concerned, provided the invention be of some use and benefit. Nor does the simplicity of a device indicate in any way the absence of utility, for this is a recommendation of the usefulness of the article rather than an objection thereto. The existence of utility in an invention is not to be determined by comparing it with other arts and devices, but is rather to be ascertained by an examination of the particular art or device in question. It is not essential to the patentability of a device that it should supersede or be superior to others previously used for the same purpose; nor does the fact that an invention has been displaced by some subsequent invention import a lack of utility. If, however, a patented article rapidly takes the place of all others of similar kind and is successful commercially, these are considerations tending to show that the public welfare has been advanced by its production and that it is characterized by utility within the meaning of the patent laws."

THE EIGHT-HOUR DAY IN COAL MINES.

A REVIEW OF THE EFFECTS OF THE EIGHT-HOUR DAY ON OUTPUT AND WAGES AS DISCLOSED BY THE REPORT OF THE BRITISH COMMITTEE OF INQUIRY.

Engineering.

THE report of the Committee of Inquiry appointed to investigate the probable effects of the proposed establishment by law of a uniform eight-hour day in English coal mines has been published and is in many respects a valuable and interesting document. The following extracts are taken from an editorial in a recent number of *Engineering* which deals with the findings of the Committee with regard to the effect of an eight-hour day on output and wages, a problem which is of great importance in America also where agitations for the establishment of a legal eight-hour day for miners are by no means unknown.

"The first part of the report deals with the effect of limitation to an eight-hour day upon production. The Committee find that at present the average time spent underground on a day of full working by all persons employed in mines is 9 hours 3 minutes, the time being reckoned from the winding of the first cage of men down the pit to the winding of the first cage of men of that shift up to the surface. (This

is the basis adopted by the Committee for the reckoning of an eight-hour day from bank to bank.) To reduce this period of 9 hours 3 minutes to one of 8 hours would reduce the aggregate hours underground, in a week of full working, by 10.27 per cent., assuming the customary short and idle days to remain as at present. On these customary short and idle days there is a loss of time within the eight-hour limit amounting to 6.48 per cent. of the present theoretical full working time. For a maximum eight-hour bank-to-bank day the Committee give the following possible averages:—

1. Six days of 8 hours each..48 hours.
2. Five days of 8 hours, *plus* present short day (involving abolition of customary idle days, and also customary short days not falling on Saturday) .....46 hrs. 13 min.
3. Present arrangement of idle and short days, but all full days reduced to 8 hours .....44 hrs. 45 min.

"These figures are, of course, not hours of work, but include meal-hours and time taken to go to and from the place of work.

"Now a reduction of such magnitude in the hours of labour as is shown by No. 3 above must necessarily cause a great decrease in the production of coal, but the Committee have endeavoured to find out whether some time that is now lost might not be recovered under the new *régime*. They find no saving of any importance is to be looked for in the customary total stop-days or customary short days of less than eight hours; but they do expect that a material saving can, and will, be made from the time that is at present lost owing to stoppages at the pits and to voluntary absenteeism. We are not prepared to accept completely the reasoning by which the Committee arrive at this latter conclusion, as factors enter into the question to which they do not appear to have given proper weight; but for the moment it may be accepted, as even with such a saving of time for work as is thus made possible the Committee still find that some diminution of production would follow the statutory reduction of hours. Other means of saving time have, therefore, to be looked for, and naturally the Committee try to see if these may be found in improvements in the mechanical equipment of collieries, in the possibility of sinking new shafts and of using ventilation (upcast) shafts for winding, and in the extension of the multiple-shift system. Each of these possible remedies is carefully examined by the Committee, but the conclusions arrived at do not seem to us to be encouraging to the advocates of the rigid eight-hour day. Much of the increased production of coal in recent years is undoubtedly due to the use of mechanical coal-cutters and conveyors; and still further increase is to be looked for from the more general use of these machines; but if a rigid time-limit for working be imposed, the use of such machines will be checked, and probably made much less extensive than it now is; for their method of operation makes it absolutely essential to have an elastic shift for the men attending to them. This has been made quite clear to the Committee, who find that in any limitation of the working day to eight hours the question of exemption for those in attendance on mechanical coal cutters and conveyors must be considered, as a strict observance of a limited day in their case would, in our opinion, greatly interfere with the development of this method of mining. It may be true, as the Committee point out, that the men who are at present actually engaged in this kind of work are few in number; but if production is not to be reduced, mechanical cutting must be greatly increased, involving a large increase in the number of men attending to the machines, so that in time the exempted class must grow to large proportions.

"Managers would undoubtedly, in many cases, like to adopt the multple-shift system, but they are prevented from doing so by what the Committee call the systematic opposition of some of the local trade unions to the institution of a double-shift on what they conceive to be grounds of trade policy. And even if this opposition were withdrawn, where is the labour to be obtained? The ordinary unskilled labourer may be induced to take employment at a colliery as a surfaceman, or even underground, but he cannot be a hewer without serving an apprenticeship, and it is the

duplication or multiplication of the class of hewers that is absolutely necessary if the multiple-shift system is to be introduced. Compare, then, the following two conclusions at which the Committee have arrived:—

We are of opinion:—

"That for these collieries the output of which is limited by mechanical conditions —*i. e.*, their capacity for haulage and winding—and which are unable to improve their mechanical equipment, *the double shift would be a necessity.*

"That the principal, and perhaps, at present, insurmountable obstacle to an immediate adoption of the multiple-shift system is *the impossibility of procuring the necessary labour.*"

"From such conclusions it is abundantly clear that even if in the course of time a fresh supply of labour, either home or foreign, could be obtained for the mines, the sudden reduction of the hours of labour can only result in a very considerable reduction of output. The Committee recognise this fact. They find that the extent of the reduction would vary greatly in the different colliery districts, and be most serious in those districts—such as Lancashire and South Wales—in which at present the longest hours are worked. They add that the deficiency would be increased beyond the amount they have calculated unless certain relaxations of a rigid rule were made for certain classes of workers, numerically small; that similar temporary and permanent relaxations might be found to be necessary in the interest of the safe working of the mine; and that in certain classes of mines, such as the house-coal mines of the Forest of Dean, and the thick-seam mines of South Staffordshire, the difficulty of adapting the work to the reduced hours would be so great that it might be necessary to make special regulations for such cases. Thus do we find ourselves forced into exceptions from the rule on every side; and when we note, at the same time, how closely the working-day at present approximates to an eight-hour day, bank to bank, in many parts of the country, we confess ourselves unable to see any justification for Parliamentary interference with liberty of contract in this industry.

"We have yet to consider, however, the probable effect of the proposed change upon wages. The Committee find themselves unable to give a definite conclusion on this point. But they say, 'An immediate advance of prices, wages, and demand for labour would appear to be the inevitable consequence of a legal limitation of hours, which involved an immediate reduction of output.' Few will venture to doubt this conclusion, but the point deserves fuller consideration. In most other departments of labour the ordinary economic law of supply and demand holds good; but, as the Committee point out, this is not true of the mining industry, and, consequently, in the words of the Committee, 'any effects consequent upon legislative regulation of an industry would be intensified in the case of this particular industry, both in regard to prices and to employment and wages.' Hewers are paid by piece-work on a tonnage rate, and the Committee think that by a re-arrangement of the time of working under the proposed eight-hour day it would be quite possible for hewers to spend the same total time in the mines as with the present average of 8 hours 36 minutes for full days, and to produce the same amount of coal as they do at present. The Committee, therefore, are of opinion that there is no valid reason why the introduction of such a limit to the day, taken by itself, should become the occasion of an alteration in the basis of the hewers' wages. This, however, seems to overlook the fact that the tonnage rate is itself based on an assumed day-rate, and the Committee agree that with regard to workers on a day-rating there would have to be either a retention of the present day-rate, with an increase of the real remuneration per hour, or a reduction of the day-wage in proportion to the reduction of hours. It is not to be expected that the men who demand the eight-hour day would for a moment accept the latter alternative; and if the day-wage is increased, the hewers will also demand an increase in the tonnage rate. Now, what will happen if this takes place? It has been clearly shown by the evidence that these men, when once they have earned what they consider an adequate weekly wage, take an idle day or days. An increased tonnage rate will enable them to earn that sum by a smaller

number of hours of work, and when they have earned it, they will take idle days, as before. Thus the decrease in absenteeism, which the Committee look for under the new *régime*, is not, in our opinion, to be expected; and if absenteeism continues as before, the production must be still further decreased, and the increased scarcity will give rise to a demand for a still higher wage. It is only when we consider the different factors together, and not separately, that we get a proper view of the situation, and the report of the Committee suffers somewhat in this respect. We do not, however, blame the Committee, as they have strictly followed the lines of inquiry laid down for them in the terms of reference."

HONESTY IN PUBLIC CONTRACT WORK.

A DISCUSSION OF MEANS OF PREVENTING FRAUD IN THE LETTING AND EXECUTION OF PUBLIC CONTRACTS.

Cassius E. Gillette—Engineering News.

THE engineer employed in public work has no higher duty than the prevention of fraud in the execution of contracts. It is a duty which he owes to the municipality which employs him, to the engineering profession, and no less to himself. In a recent number of *Engineering News* Major Cassius E. Gillette, writing on the responsibility of the engineering profession for the conduct of public contracts, outlines the various ways in which frauds may be perpetrated and the precautions which the engineer should take in advertising for bids and in drawing specifications. The following is an abstract of the paper.

Major Gillette first emphasizes the necessity of extensive advertising of all pending contracts in papers of every political complexion and, if large, in the technical journals. An office list of contractors should be kept and notices of pending contracts should be mailed to every one on the list without request. In nearly every case of fraud the advertising has been a minimum and no office list of contractors has been kept.

"As a further check, the engineer should be required to promptly furnish to any one who asks it, full information as to the advertising of any contract, past, present or future. In every case of fraudulent contract known to the writer, the office involved has been run like a secret service bureau, where the divulging of anything official by the employees was looked upon as a serious offense, and anything like interest on the part of the public was regarded as an impudent intrusion. In this matter, it is fair to say, renegade engineers are aided by reputable engineers, who for minor reasons keep all official matters secret. After many years experience and much observation, the writer ventures the opinion that in an engineer office responsible for public work, all matters should be open to the public except those under preparation for the official action of superiors."

Finally, to prevent combinations among bidders, and especially to prevent a favored bidder from using unfair methods, there should be no requirement which would make it necessary for a bidder to let anyone else know that he is going to bid.

Major Gillette mentions the following essentials which must be observed if specifications are to provide for fair competition:

"Specifications must provide for each bidder bidding on exactly the same thing, and . . . . . they must not be incomplete, vague or capable of two constructions. Such vagueness would deter bidders and would also enable a favored contractor to rob the public.

"The contractor should not be required to take the risk of any contingencies as to unknown conditions to be developed by the work. If the contractor is to be held responsible for the contingency, he must bid as if the contingency were sure to arise and the municipality must therefore pay for it whether it arises or not; but if the municipality take the risk, it need not be paid for unless the contingency actually arises. A contingency arising, even though

covered in the bid price, can generally be used to cover fraudulent favoritism. Most contingencies can be covered by itemized bids.

"Nothing should be left to the 'discretion of the engineer' except it be definitely stated in the specifications upon what detailed principles such discretion will be exercised.

"Unit prices should be compulsory for all work subject to changes during construction. A lump sum contract coupled with the right reserved to the engineer to make changes and fix the price thereof is simply giving the engineer carte blanche in the public treasury. It is precisely the equivalent of doing the work with no specifications at all.

"While in the hands of honest engineers such provisions are all right, yet they open the door so widely to fraud that engineers who prescribe them should be looked upon just as medical men look upon a doctor who advertises fraudulent remedies. The writer has investigated contracts where many thousands of dollars had been diverted into the contractor's pockets by this process.

"Provisions should be required in every public specification to prevent robbery by unbalanced bids. This clumsy device has doubtless been in use by dishonest contractors and venal officials longer than the sandbag has been used by thugs, and is an even less reputable means of robbery.

"It consists in the engineer or other purchasing agent very much underestimating one item in his estimate of quantities used to canvass the bids. His partner in crime bids very high on this item and low on larger items. The small quantity called for in the estimate does not increase his bid much, so that it will figure out to be the lowest in the aggregate and he gets the contract, in the execution of which the great increase in the high-priced item makes his profits look like 'frenzied finance.'

"Public treasuries have been robbed of untold millions by this simple process. The remedy is to forbid the increase of any item more than ten per cent. It will occasionally happen that the quantity of some item cannot be estimated within 10 per cent. In that case all that is necessary is for the engineer to estimate the unit prices and accept no bid that exceeds any one of them by more than 10 per cent.

"Subletting of contracts should be absolutely forbidden. It frequently happens that a political boss acts secretly through an agent as a contract broker, for which service he charges what are practically enormous fees. Even where work is honestly conducted, any subletting that is done should be done by the engineer. The cost of doing it is only a trifle in comparison with the percentage which the main contractor will always add.

"The contract should be awarded invariably to the lowest bidder. This presupposes that the bids are all for identical articles or work. It also supposes that the bid is fortified by an adequate and reliable bond. With such a bond the personality of a bidder should disappear. I am fully aware that occasionally a work will be delayed by awarding the contract to some bidder who is habitually slow, or who is ill-equipped with plant or capital, but the specifications and the bond can be made to fully cover every contingency. Where trouble has been experienced with low bidders, it has been due to the fact that bonds have not been enforced and that penalties or liquidated damages have been used merely as threats to hurry contractors; and the remedy for these troubles has been sought in the objectionable method of ruling out the lowest bidder when he did not suit the engineer. This principle is wrong and opens the door to favoritism and graft.

"Even if the execution of the work is occasionally delayed by following the rule to always award the contract to the lowest bidder, if his bond is good, such loss measured in dollars will be a trifle in the long run compared with the financial losses that are inevitable under the other system. The moral loss caused by the increased opportunity for graft in public business cannot be measured in dollars.

"The names of all persons interested in the bid should be set forth in the bid itself. Every bid should be accompanied by an affidavit setting forth the names of every person having a present or future contingent interest in the bid, and vouchers for payment should contain similar affidavits as to interests in the contract.

"If the engineer is not true to his duty, contractors will sometimes pool their bids, and create a competition that is apparent but not real. This is most frequent where special plant is required, as in dredging for example. However, if the above affidavit be worded to include all persons interested 'by pooling arrangement or otherwise' the danger of such combination will disappear, especially in localities where the making of false affidavits punished as perjury.

"The profession should look askance upon any engineer who does not comply with these principles, whether embodied in local laws and ordinances or not. And if any laws or ordinances interfere with the proper compliance, their existence should be noted in the specifications."

ELECTRIC HAULAGE ON EUROPEAN CANALS.

DETAILS OF METHODS AND COSTS OF ELECTRIC CANAL TRACTION AS DEVELOPED IN FRANCE AND GERMANY.

United States Consular Reports.

THE following details of electric canal haulage methods and costs on European waterways are taken from a paper presented before the London Chamber of Commerce by Prof. E. W. Marchant of the University of Liverpool and reprinted in a recent United States Consular Report. The information forms an interesting supplement to that contained in a review in these columns in December, 1906, in which only the Teltow Canal was considered.

"In order that a system of electrical haulage may be financially successful a good and regular traffic is necessary. It is difficult to say definitely when an electrical haulage scheme becomes economically desirable on a canal, as the results obtained must depend very largely on local conditions; but on the Teltow Canal in Germany the conclusion arrived at was that the adoption of electrical haulage, on purely economical grounds (that is, taking into account only total cost of haulage, including interest and depreciation on the haulage plant) saved money when the traffic exceeded 2,000,000 tons per annum. This result applies of course solely to this canal, which is the most elaborately equipped of its kind in the world, the total cost (including generating stations), with a tractor track laid on both banks, being about £6,000 (£29,199) per mile. With a smaller capital expenditure a saving would result, of course, when the traffic was considerably less than 2,000,000 tons.

"Tractors running on an ordinary towpath have been used at Brussels, on the Charleroi Canal, and at Douai, on the Canal d'Aire et de la Deule. The advantage of this type over others lies entirely in the small cost of equipping the canal for this type of traction. The tractor used on both these canals weighs between two and three tons and carries a motor of 10 h.p. It has flat-rimmed cast-iron wheels; at Douai these wheel rims were of the corrugated form ordinarily employed for road traction engines. Current is collected from overhead wires; where continuous current (Douai) is employed only two trolleys are required, while with three-phase current (Charleroi) three become necessary. The tractor carried a seat for the driver and a controller for the motor. The cost of equipping the track with the necessary trolley wires amounts to about £300 ($1,460) per mile, using wooden poles. In spite of this the system is a very uneconomical one. The efficiency of the tractors is only 40 per cent., while the wear and tear on the machinery is very heavy.

"It will be seen, therefore, that the majority of the wearing parts require repacement in just over two years. The main drawback, however, to this system is the heavy cost of maintaining the towing path in proper condition. While horse traction requires only a light cinder or gravel track, electric traction with 2½-ton tractors requires a good macadamized road, and it was found at Douai that the average cost of upkeep was increased from 234 francs per kilometer ($45.16 per 0.6214 mile) when horses were used on the track to 875 francs ($168.87) with electric tractors. The wear on the towpath due to the running of these heavy tractors on the

canal banks is particularly noticeable at Douai on that part of the canal not yet equipped with rail traction. The driver in some parts has great difficulty in maintaining his place in the tractor, even at the low speed of two miles an hour at which it is running. It is now generally agreed that this system of haulage is one that is much more costly (in spite of the small capital outlay) than haulage by means of tractors running on rails.

"The two most important installations in which electrically driven tractors running on a light railway track are used for towing canal barges are at Douai, on the Canal d'Aire et de la Deule, and on the Teltow Canal south of Berlin.

"The electric installation at Douai with rail tractors has been in operation for over a year and affords a very interesting comparison with the electrical system on the same canal, in which tractors running on the banks are used, which has been in operation since 1897. The overhead trolley wire is of the usual type used on tramways, with the exception that it is supported from below, as the trolley collector runs on top of the wire, instead of pressing against the lower side of it. The return path for the current is through the rails, which are bonded as in the ordinary tramway. The track is of rails weighing 40 lbs. per yard, laid on wooden sleepers and ballasted with cinders and broken stone, and the cost of laying is about 17,000 francs per kilometer ($5,353 per mile). The cost of upkeep of this track is estimated at under 400 francs per kilometer ($121.17 per mile). The locomotives running on this weigh eight tons and are capable of exerting a pull of 1.3 tons with the rails in their normal condition. Efforts as great as 1.6 tons have been obtained when the rails were exceptionally dry and clean. This effort is sufficient to tow four boats carrying 290 tons each, at two miles per hour. The tractor is equipped with two 20-h.p. traction motors, operated by a series of parallel controllers of the ordinary type used on tram cars. The track is laid on one side of the canal only, so that locomotives going in both directions travel on it. When two barges meet they exchange locomotives and proceed on their way. This arrangement has the advantage of keeping a locomotive driver more or less on a fixed beat. At Teltow both banks are equipped with tractors, so that no difficulty about passing occurs. The canal in this case is divided into sections, on two of which electric locomotives are used. A number of locomotives are maintained on each section—that is, they travel along the section, cross over by a bridge, and return along the other bank of the canal. It is intended when the canal is in full operation to maintain, as far as possible, a fixed time schedule for the barges, so as to avoid delay at the ends of the sections.

"The weight of the locomotives in use on each of the canals referred to is about 8 tons, and they are equipped with motors of 8 h.p. (Teltow) and 20 h.p. (nominal) at Douai. The Teltow tractors are designed to tow two barges, each loaded with 600 tons, at a speed of 2.5 miles per hour, and besides being fitted with driving motors have several special electrically operated appliances so arranged as to enable the locomotive to be controlled by one man.

"The tractors at Douai are much simpler, and are a great deal cheaper, although the two motors are of 20 h.p. The amount paid for a locomotive is 8,000 francs ($1,544), and the cost of upkeep is estimated at about $90 per annum. The tractive effort required to haul barges depends on a great number of conditions, the most important of which are the speed and the ratio of barge section to canal section. At Teltow, with a ratio of 1 : 5, and at a speed of 2.5 miles per hour, the tractive resistance is very nearly 2 lbs. per ton with a 600-ton barge. The energy consumed is 5.6 watt hours per ton-mile, costing 0.0112 cent per ton-mile, and the efficiency of the locomotive is 67 per cent. At Douai, on the Scarpe detour of the Canal d'Aire et de la Deule, the ratio of barge section to canal section is 1 : 5.22. On the main canal it is only 1 : 3.89; at a speed of two miles per hour the tractive resistance is 2.5 lbs. per ton, with 200 or 300-ton barges. The energy consumed per ton-mile is 7.2 watt hours, costing 0.0144 cent per ton-mile, and the efficiency of the locomotive 68 per cent. It is significant that no greater speed than 2½ miles an hour is allowed on the German canals, while on the French canals a limit of two miles an hour is given. The objections to a higher speed are the increase in the silting up of the canal, the

greater wear on the banks, and the greatly increased tractive effort required. All experience shows the inadvisability of increasing the speed of towing on canals to any very great extent, whatever method of haulage is employed.

"The total cost of electrical haulage on the Teltow Canal for different traffics are as follows: At a total traffic of 2,000,000 tons, 1.72 cents per ton-mile; traffic of 3,000,000 tons, 1.48 cents per ton-mile; traffic of 4,000,000 tons, 1.2 cents per ton-mile. At Douai the gross receipts per ton-mile (net load) were 1.32 cents, and the expenses 0.94 cent. Of the expenses 0.0352 cent represents the cost of energy used for barges and the remainder the upkeep charge on the plant, labor charges, etc. The traffic on this canal has increased from 1,000,000 tons in 1900 to over 3,500,000 tons last year.

"One of many great advantages which the use of electrical energy possesses over all other methods of mechanical towing is the fact that it gives a supply of power available within limits at any point on the canal banks. Some of the uses to which electrical energy has been put on the canals where electric haulage has been adapted are as follows: Electric capstans are used at the lock; electric cranes at loading places; electrically driven winches are used at a harbor designed for ship repairs by which any boat up to 150 feet long can be hauled out of the water on carriers, thus obviating the necessity for a dry dock; an electrically driven pump is fitted at the lock to pump back water into the upper reach (Havel), in case the loss by lockage is too great, and electric lights are placed at the lock to enable it to be used at night; electric power has been used for lighting a canal, and for operating locks and swing bridges, the saving in labor effected by its use being estimated at 50 per cent.

"Electrical haulage has only proved successful on canals on which there is a good volume of traffic. In all successful installations electric locomotives running on the towpath have been employed in preference to tugs. The economy in general upkeep of the canal in getting rid of the wash from the screws is sufficient, in some cases, to compensate for the interest and depreciation charges on the electrical equipment. The total cost of electrical haulage per ton-mile at Douai is $.094 cent, with a traffic of 3,500,000 tons per annum."

A CODE OF ENGINEERING ETHICS.

A SUMMARY OF THE PROPOSED CODE OF ETHICS DRAWN UP BY A COMMITTEE OF THE AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS.

Proceedings of the American Institute of Electrical Engineers.

ONE of the most valuable functions of the great national engineering societies is the establishment and maintenance of high standards of professional conduct. The American Institute of Electrical Engineers recently appointed a committee to formulate a code of ethics, the report of which was presented at the last annual convention. This committee, composed of Chas. P. Steinmetz, Harold W. Buck, and Schuyler S. Wheeler, considered it impracticable to cover explicitly all the conditions met with in the work of the electrical engineer and laid down only the general principles of professional conduct. Many of the points mentioned in the code, therefore, apply equally well to all branches of the engineering profession.

In the first section of the code the electrical engineer is advised to investigate fully the character of every concern before entering into professional relations with them, even if he is employed to perform only legitimate engineering work. An engineer permitting the use of his name in any enterprise becomes morally responsible for the character of the latter. He should also take care that the credit for engineering work is attributed to the real authors of such work.

Regarding the relations of the electrical engineer to his employer, customer, or client, the report lays down the following rules:—

"The electrical engineer should consider the protection of his client's interests as his first obligation, and therefore should avoid every act that would be contrary to

this duty; if any other consideration such as professional obligations or restrictions interfere with his so acting, in accordance with the expectation of his client, he should inform him of the situation.

"He can honorably accept compensation, financially or otherwise, from one side or party only, interested in the same matter. The electrical engineer, whether consulting, designing, or operating, may therefore not accept commissions, either directly or indirectly, from other parties dealing with his principals.

"Electrical engineers in a position to decide on the use of inventions, apparatus, etc., should not be financially interested in their use, as by receiving a royalty, etc., unless the matter is clearly understood by the client.

"Electrical engineers should not accept employment while financially interested in a rival concern except upon the express permission of both parties. An electrical engineer may be employed by more than one party, as in the case of a consulting engineer, when the interests of the parties do not conflict and it is understood, as is usual in such cases, that he is not expected to devote his entire time to the work of one party, but is free to enter into other engagements. A consulting engineer permanently retained by a party should notify other prospective employers of this affiliation before entering into relations with them. A consulting engineer when not exclusively retained by one side may advise rival concerns, with the full knowledge of all of them and upon taking care that the interests of the parties do not conflict in the particular matter handled.

"Operating engineers should consider themselves responsible for defects in apparatus or dangerous conditions of operation, should bring the same to the attention of their employers and urge remedial action. If the causes of danger are not removed they should withdraw.

"An electrical engineer should in general be considered directly responsible to his employer or client for the successful fulfilment of the work upon which he has been engaged and for its satisfactory performance as a whole. It should therefore be clearly understood at the outset just what the extent or the limitations of responsibility of the engineer are to be. Whether he has been employed merely as a designer or whether he is retained to design and to superintend construction; whether to design only the chief features, or to pass as well upon all details of the apparatus that is to be installed. Attention should be directed to the fact that defects in the manufacture of material or apparatus is a matter distinct from the matter of design or installation. An engineer should not be held responsible for the unsatisfactory performance of a plant resulting from defective apparatus furnished, unless he has undertaken to include the subject."

With regard to the ownership of the records of the electrical engineer, the code states:—

"If in executing his work, the electrical engineer uses data or information which are not common and public property, but which he receives, directly or directly from his employer, and is not of such character that his attention would have been directed to it regardless of his relations to his employer, the products of his work, in the form of inventions, plans, designs, etc., are not his private property, but the property of his employer, though the engineer may be entitled to special remuneration for such inventions, etc.

"If in the execution of the work the engineer uses only his own knowledge or data or information which are public property by prior publication, etc., and receives no engineering data from his employer or customer, except performance specifications, the results of his work, such as inventions, plans, designs, etc., are the private property of the engineer, and his employer or customer is entitled to their use only in the specified case.

"All the work done by the engineer in the form of inventions, plans, designs, etc., which are outside the field of engineering for which his employer has retained him are the engineer's private property.

"When an engineer or manufacturer builds apparatus from engineering designs supplied to him by his customer, the designs remain the property of the customer and should not be duplicated for other customers without express permission. When the engineer or manufacturer and his cus-

tomer are jointly to work out designs and plans or develop inventions, a clear understanding should be arrived at before the beginning of the work regarding the proportionate rights of ownership in any inventions, designs, etc., that may result, since in such case both parties should be considered to have rights therein.

"Any engineering data or information which an electrical engineer obtains, directly or indirectly, from his employer or customer, or which he creates as a result of such information, must be considered by the engineer as confidential; and while the engineer is justified in using such data or experience in his own practice as going towards his education, the publication thereof without express permission is improper, as is also its use in producing for other parties, work that is characteristic of the original customer or employer.

"Designs, data, records and notes made during his engagement by an engineer employed under permanent engagement, and referring to his work, are his employer's property. The same matter in the case of a consulting electrical engineer are the property of the consulting engineer.

"A customer, in buying apparatus, does not acquire any right in its design beyond the use in the apparatus purchased. A customer of a consulting engineer does not acquire any right to the plans made by the consulting engineer except for the specific case for which the apparatus was built or the plans made."

The proper relations of the electrical engineer to the general public are specified thus:—

"The electrical engineer should endeavor to assist the public to a fair and correct general understanding of engineering matters, spread the general knowledge of electrical engineering, and discourage wrong or exaggerated statements on engineering subjects published in the press or otherwise, especially if these statements are made for the purpose of, or may lead to inducing the public to participate in unworthy schemes.

"Controversies on engineering questions, however, should never be carried on in the public press, but should be confined to the technical press and the engineering societies.

"First publication of inventions or other engineering advances should not be made through the public press but rather through the technical press and the engineering societies.

"The publications which an electrical engineer is justified in making through the public press should therefore be of a historical, educational, instructive or similar character and should not relate to controversies between engineers or on engineering questions, to new inventions, etc., nor contain technical criticisms of fellow engineers, and it should be considered unprofessional to give opinions without being fully informed on all the facts relating to the question, and on the purposes for which the opinion is asked, with a full statement of the conditions under which the opinion applies.

"In giving expert testimony before judicial bodies, the electrical engineer should confine himself to brief and clear statements on engineering or historical facts. He should not give personal opinions with-He should not give personal opinions with-pleading on one side or the other."

THE PUBLIC UTILITIES LAW OF NEW YORK.

A DISCUSSION OF THE REGULATION OF CORPORATIONS BY COMMISSIONS AND OF THE NEW PUBLIC SERVICE COMMISSION OF NEW YORK.

Engineering News.

MR. KERRY'S article on the Canadian Railway Commission in another part of this number of THE ENGINEERING MAGAZINE describes a notable attempt to obtain national control and regulation of public service corporations, the jurisdiction of this commission being limited, however, to transportation companies. Recent legislation in New York State has created a commission with somewhat similar powers, operating of course over a smaller area but with its sphere of influence enlarged to include gas and electric lighting companies. An editorial in a

recent number of *Engineering News* makes some interesting comments on this new law and on the general question of government control of corporations by means of commissions.

"By the terms of the law, the whole state is divided into two districts, the first comprising the city of Greater New York, and the second, all the rest of the state. In each of these districts a 'Public Service Commission' of five members is created and is given jurisdiction over all railways, street railways, common carriers, and all works for distributing gas or electricity for light, heat or power. It will be seen that several other important classes of public utility corporations operating under franchises, such as water companies, and telephone companies, are not included. The term 'common carrier,' however, includes express companies, sleeping car companies, and freight line companies.

"Turning now to the powers to be exercised by these Commissions, it should be said that for the most part the requirements are the same as those of existing law. Discrimination between persons and places, false billing, free passes, and similar practises are prohibited as in existing laws. In addition, however, the Commission is given full authority over all the operations of the corporations under it. While the primary responsibility is on the corporations to render good service to the public and charge only reasonable rates, the Commission has full authority to inquire into and compel the remedying of any dereliction in either respect. It is because the bill does go further than any previous measure in clothing the Commissions with power over these public service corporations, that such a measure of opposition from the corporations has been aroused.

"It is around the requirement that 'all rates shall be reasonable,' that future controversies are certain to be waged. No one objects to this provision. Every corporation officer will deny that his company ever charges a rate that is unreasonable. But when we get down to the definition of a reasonable rate, the two sides are far apart. It will be one of the most difficult duties of the new Commissions to frame a definition of a reasonable rate —one which will be accepted alike by the public and by the corporation managers, and which will stand the test of the courts. It is even among the possibilities that the constitutional powers of the new Commissions may be found inadequate for the settlement of this question. It may be necessary to resort to the legislature for the enactment of a law defining in general terms what conditions a reasonable rate charged by a public service corporation shall fulfil.

"Quite as important a part of the law as the clauses defining the powers of the Commission are those fixing its make-up. In nearly or quite all previous attempts at state regulation of monopolies, the mistake has been made of creating a regulating body inadequate in numbers and too poorly paid to secure efficient service. What would be thought of a Board of Bank Directors who employed a two-dollar a day laborer to watch a ten-thousand dollar a year cashier and prevent him from making way with the funds? Yet this is on a par with most of the experiments which have been made in regulation of railways by State Commissions.

"For the first time now, the State of New York recognizes that the task of controlling the public service companies of the state with their billions of dollars of capital is a task demanding all the energies and time of the highest class of men that can be secured; and it has declared its willingness to pay the market price for such men. Each of the five members of each Commission is to have a salary of $15,000 per annum and his expenses. The contrast between this and all previous attempts at Commission control over corporations is one which the corporations themselves fully appreciate. It ought to be possible to secure for this sum men of as high character and standing as the judges in the courts of law, or those who lead in other professions, or those at the head of private business enterprises.

"Of course it goes without saying that men who can be purchased or controlled by influence can nullify the intent of the law to protect the public from extortion, while a demagogue could misuse such a position with resultant disaster to the vast interests dependent on his decisions. But exactly the same thing may be said of

the men in executive positions, or in the legislature or on the Bench. The public must trust someone; and there is no reason apparent why the men on the new public service commissions should not be as deserving of trust and public confidence, and as likely to give the corporations as well as the people a square deal as any officers of the legislative, executive or judicial department of Government.

"We see absolutely no justification for the outcry against 'Government by Commissions,' which the corporation defenders are emitting. Chancellor Day of Syracuse University, who is doubtless the most unique representative of the corporations, in his baccalaureate 'sermon' on June 9 is quoted as saying:

"'The distinction between the executive, judicial, and legislative order is disappearing in a form of oligarchy named "commissions.

"'The laws are taken out of the hands of Congress and the legislature and put into the hands of commissions, subject to executive appointment and executive pleasure.'

"The facts are, however, that the delegation of certain Governmental functions to Commissions is an absolutely necessary step in the evolution of Governmental machinery. No legislature and no court can possibly do the work that modern conditions make it necessary for the Government to undertake. A Commission is nothing more than a body of executive officers to whom a particular task is assigned.

"The absurdity of the position that the law of supply and demand is sufficient protection for the people has been proved over and over again. Every honest and intelligent authority on public questions recognizes that there are to-day only two alternatives, if 'government of the people, by the people and for the people is not to perish from the earth.' These alternatives are Government control of monopolized industry or Government ownership. It is the former alternative which the State of New York is about to attempt; and every intelligent and patriotic citizen will watch the operation of the new Public Utilities law wth hopeful interest.

"In conclusion, we may appropriately express the opinion that in the selection of members for the new Commissions, the engineering profession should be adequately represented. These Commissions must investigate and render opinions upon many technical questions in connection with the operation of railways, electric plants, gas plants, etc. It will be of great advantage if the Commissions are not obliged to rely wholly on experts whom they may hire, but have in their own membership men able to form intelligent opinions on any technical matter brought before them. The other necessary elements in the candidates, such as moral and professional standing, fidelity to duty, judicial temperament and broad culture, can surely be found among members of the engineering profession as readily as among those engaged in any calling."

ROCK DREDGING.

EXPERIENCES IN THE REMOVAL OF SUBAQUEOUS ROCK BY MEANS OF THE LOBNITZ ROCK BREAKER.

E. Quellennec and J. W. Sandeman—Institution of Civil Engineers.

THE removal of subaqueous rock has, up to comparatively recent times, been accomplished altogether by drilling and blasting, at best a laborious and costly process, and attended in navigable waters with great inconvenience to shipping. Recent experiences on several large works have shown, however, that many of the difficulties of rock removal under water can be overcome by the use of heavy rock breakers which not only effect a saving in the cost of excavation but leave the material in a much more satisfactory state for handling by bucket dredges. The following details of dredging by the rock breaker method are taken from papers presented by Messrs. Edouard Quellennec and John W. Sandeman at the Engineering Conference of the Institution of Civil Engineers.

Mr. Quellenec's paper deals with experiences extending over twenty years on

the dredging work for the Suez Canal Company.

"Hitherto rock has only been encountered in the southern portion of the Suez Canal, comprised between kilometre .85 and Suez (kilometre 160), a distance of 46 3-5 miles. This rock is found in the form of nearly horizontal layers of variable thickness, scattered throughout the whole of this region in beds of very different lengths, generally less than 100 metres (328 ft.), and never exceeding 400 metres (1312 ft.); and these beds of rock stretch across the whole width of the canal. The total area of rock actually met with in the bed of the canal amounts to 300,000 square metres (358,800 square yards). The rock is very variable in composition, consisting of limestone more or less hard, calcareous or silicious agglomerates, generally containing shells, calcareous tufa of a red colour, gypsum, and alabaster. The hardness, also, of these strata is very variable; generally they are not very hard; but, nevertheless, there are some beds of compact limestone and silicious conglomerates which are very hard. In constructing the canal, the rocky beds were excavated out of water.

"In 1884, when the company determined to enlarge and deepen the canal, the problem of removing the rock under water had to be considered. It was then decided to disintegrate the hardest rock (compact limestone and silicious conglomerate) by subaqueous mines; but the company accepted the proposal of Mr. Lobnitz, of Renfrew, to use a rock-breaking dredger in dealing with rock of average hardness. This dredger consisted of a set of ten steel rock-cutting rams, each weighing 3½ tons, placed on a very strongly-constructed bucket-ladder dredger, which could easily raise the rock shattered by the rams. Mr. Lobnitz's idea was not new, since for forty years the system of shattering rock under water by rams has been employed at the port of Cette in France; but Mr. Lobnitz has made improvements in the construction of the rams, and has devised various contrivances for the suspension of the rams and the arrangement of the winches, which have rendered the rock-breaking apparatus thoroughly practical and economical. It soon became evident in working that Mr. Lobnitz's rock-breaking dredger did not furnish an advantageous output, owing to the mistake of having combined two such different tools as a chain of buckets and a rock-cutter on the same vessel; for when one of them is working the other is necessarily idle. The rams were consequently removed from the dredger, and installed upon special pontoons. The output was thereby considerably increased, but it still remained moderate, owing to the insufficient weight of the rams; for fourteen to sixteen blows of the ram were required to shatter moderately hard rock for a thickness of only 20 in., so that the breaking up of rock cost on the average 7s. 3½d. per cubic yard.

"When in 1897 it was decided to deepen the canal to 31 ft. the removal of the rock had to be considered again, and an investigation of the method of extracting the rock by mining and explosives proved that it could not compare in economy with rock-cutters. Moreover, the experience gained with the little rams of 3½ tons, and later on with rams of 5 tons, furnished an assurance that the employment of heavier rams would solve the problem in a very satisfactory manner. Besides, in the special case of the Suez Canal, the use of explosives is subject to numerous inconveniences, from which rock-cutters erected on floating barges are exempt, especially with regard to the obligation of being drawn to one side for the passage of ships, and the necessity for divers to examine the bottom after every explosion, to ensure that no pieces of exploded rock project from the bottom. Finally, it must be borne in mind that with rock-cutters the bottom is leveled off in a fairly regular manner; whereas with explosives it is always necessary to remove a large quantity of rock below the intended level, which is the reverse of economical.

"An apparatus was finally selected, of the type designed by Messrs. Lobnitz and Co., provided with two spindle-shaped cutters of cast steel, 44 ft. 7½ in. long, each weighing 13 tons. These cutters have renewable points of very hard chrome-steel, which have been turned in order to obtain a more regular form, and also to enable the soundness of the metal on its whole surface to be verified. The cutters, or rams, placed

1 metre (3 ft. 3⅓ in.) apart, are lifted by powerful steam-winches, rapidly put into and out of gear, by means of very flexible steel cables securely fastened to the head of each ram, which arrangement admits of a very rapid raising of the rams, and the easy regulation of the height of their fall, which is usually between 5 and 10 ft. All the movements of the rock-cutting pontoon, forwards, backwards, and sideways, are rapidly accomplished by means of steam winches. The principal dimensions of the floating pontoon carrying the two rams are 100 ft. in length, 35 ft. beam, and 8 ft. in depth of hold. This apparatus, which commenced operations in 1902, after undergoing some improvement in details, has given very satisfactory results. On the average 132 blows are delivered per hour of effective rock-breaking; but allowing for stoppages, for repairs, and drawing to one side to leave the waterway clear, 83 blows are delivered by the ram per hour of work paid to the crew. The average thickness of the bed of rock shattered is 2 ft. 7½ in.; and under these conditions, the number of blows required for the shattering of a cubic metre varies, according to the hardness and also the fragility of the rock, from 1 to 40; but 40 blows is a maximum very rarely reached, and the mean is 7.1 blows per cubic metre, equivalent to about 5.4 blows per cubic yard of rock shattered.

"The cost price per blow of ram is made up as follows:—

Cost of Operations.	Small Repairs.	Large Repairs.	Repayment of Capital.	Total.
$0.160f.$	$+ 0.034f.$	$+ 0.044f.$	$+ 0.073f.$	$= 0.311f.$
$1.53d.$	$+ 0.328d.$	$+ 0.422d.$	$+ 0.701d.$	$= 2.985d.$

"As from 1 to 40 blows are required to shatter 1 cubic metre of rock, with a mean of 7.1 blows, the cost per cubic metre varies from

Francs.		Francs.	Francs.	s. d.	
0.311	× 1.0	= 0.311,	equivalent to	0 2.26	per cubic yard
to					
0.311	× 40.0	= 12.44,	equivalent to	7 6.57	per cubic yard
with a mean of					
0.311	× 7.1	= 2.21,	equivalent to	1 4.10	per cubic yard

"These prices include all expenses, with the sole exception of general charges. To these should be added the cost of raising the shattered rock by the dredgers, and transporting it to the place of deposit. These expenses vary greatly according to the locality, and especially with the distance from the depositing ground; whilst the cost of dredging the shattered rock is about double the cost of dredging in average ground."

Mr. Sandeman's paper contains the following details of the use of the rock-breaker in harbor-improvement work now in progress at Blyth, on the north-east coast of England.

"Under the scheme of improvement now in progress at Blyth, about 500,000 cubic yards of sandstone rock and shale have to be removed, and this is being accomplished by means of two of Lobnitz rock-breakers and two 700-ton hopper dredgers. Previous to 1906, about 150,000 cubic yards of rock were broken up by means of drilling and blasting, so that a comparison of the two methods may be of interest.

"The rock at Blyth is the sandstone of the Coal Measures, which varies in character from friable stone, containing fireclay, shale, and coal, to sandstone equal in hardness to basalt.

"Each rock-breaker consists of a steel barge carrying sheer-legs, from which is suspended a steel ram of 15 tons weight, 40 ft. to 50 ft. in length, and 17 in. to 19 in. in diameter, having a renewable conical point, tempered so as to combine a hard centre with a softer exterior, which, while wearing, enables a sharp point to be preserved.

"The ram is lifted by a wire rope wound upon a loose drum, driven by a friction-clutch. It is allowed to fall from a height of 8 ft., and on an average of eight to nine blows penetrates the rock to a depth of 3 ft., which is sufficient to allow of its being dredged to a depth of 2 ft. 6 in. The machine is arranged so that it can be moved on end and athwart simultaneously by chains worked by steam-winches. By means of sighting-rods on board and ashore, the barge can be moved over uniform distances. The ram was at first worked in positions 3 ft. apart, and this distance was gradually increased to 4 ft. 6 in., which was found to be close enough for either hard or soft rock.

"The average quantity of rock which one machine has broken per week, working night and day, and allowing for all stoppages, is 908 cubic yards, at a cost of 8.8d. per cubic yard. This is based on six months' working; but as it is necessary to allow for renewal of rams, the following is the actual cost per week of wages, coal, stores, and water, and the estimated cost of repairs, full allowance being made for renewal of rams and all contingencies:—

	£	s.	d.
Wages	16	1	6
Coals, stores, and water	6	10	7
Estimated cost of repairs, renewal of rams, ropes, &c.	22	0	0
Insurance at 30s. per cent. = 102*l.* per annum	1	19	2
908 cubic yards at 12.3d.	46	11	3

"The cost of one rock-breaker is about 6800*l.*, and if 4 per cent. be allowed for interest and 2½ per cent. for depreciation (the machine being well maintained), the additional cost per cubic yard would be 2.2d., making a total cost of about 14.5d. per cubic yard. The quantity of rock broken is ascertained by the number and depths of the penetrations of the ram in a given time, which are carefully recorded; and, after dredging, the amount of rock removed is checked by soundings.

"The drilling and blasting of the rock was carried out by means of a barge having six drills, which were lifted by steam-power and guided by hand. The distances between the shot-holes were 5 ft. in one direction, and 6 ft. 2 in. in the other. The blasting material, bellite, was lowered in canisters through the drilling-tubes, and fired by fuses and detonators, the holes being tamped with small gravel.

"The average quantity of rock drilled and blasted per week by means of one barge was 488 cubic yards, and the average cost of drilling and blasting was about 3s. per cubic yard. The quantity of rock blasted was ascertained by the number of holes and their depth, which was 1 ft. more than that to which the rock could be dredged, and a check was made by sounding over an area of rock before blasting and after dredging.

"Each of the hopper dredgers has two sets of buckets, one for rock-dredging, and the other for sand, clay, or gravel, having 50 per cent. greater capacity. The bucket lips are of cast-steel, and the pins and bushes of manganese steel. The lips of the buckets for rock-dredging are set at an angle of about 27 deg. to the bucket-backs, and those for sand, &c., at an angle of 55 deg. The rock is dredged into hoppers and deposited at sea, or (when required for harbour purposes) into separate barges having gridded hoppers, enabling the rock to be screened and discharged.

"In estimating the quantity of rock carried in the dredgers' hoppers, deduction has been made for water contained along with the rock.

"As compared with blasting, the rock-breaker disintegrates and breaks the rock into smaller pieces, so that the quantity lifted by the dredgers in a given time is about 15 per cent. more than that of blasted rock. The average quantity of blasted rock removed by one dredger per day of 24 hours, and allowing for all stoppages, is 158 cubic yards, and of that broken by the rock-breaker 182 cubic yards. The average number of days per annum worked by the dredgers is 227. The cost per cubic yard of dredging blasted rock is 2s. 6d. The cost per cubic yard of dredging rock broken by rock-cutter is 2s. 2d.

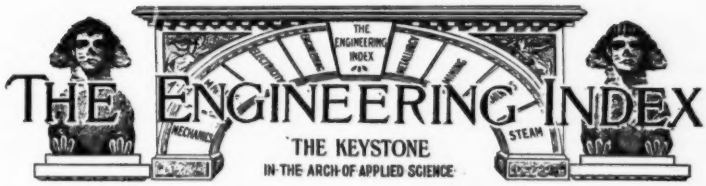
"Allowing 4 per cent. for interest, and 2½ per cent. for depreciation on 19,000*l.*, the cost of a dredger (as they are well maintained), the additional cost per cubic yard would be 8.2d. for blasted rock, and 7.1d. for rock broken by rock-breaker.

"The comparative cost of rock removal under the two systems is as follows:—

	Per Cubic Yard. s.	d.
Drilling and blasting rock	3	0
Dredging same 2s. 6d. + 8.2d.	3	2.2
	6	2.2
Breaking rock by rock-breaker	1	2.5
Dredging same, 2s. 2d. + 7.1d.	2	9.1
	3	11.6

Difference in cost per cubic yard in favour of the removal of rock by means of rock-breaker = 2s. 2.6d.

Saving on 500,000 cubic yards = 54,166*l.*"



The following pages form a descriptive index to the important articles of permanent value published currently in about two hundred of the leading engineering journals of the world—in English, French, German, Dutch, Italian, and Spanish, together with the published transactions of important engineering societies in the principal countries. It will be observed that each index note gives the following essential information about every publication:

(1) The title of each article,
(2) The name of its author,
(3) A descriptive abstract,
(4) Its length in words,
(5) Where published,
(6) When published,

(7) *We supply the articles themselves, if desired.*

The Index is conveniently classified into the larger divisions of engineering science, to the end that the busy engineer, superintendent or works manager may quickly turn to what concerns himself and his special branches of work. By this means it is possible within a few minutes' time each month to learn promptly of every important article, published anywhere in the world, upon the subjects claiming one's special interest.

The full text of every article referred to in the Index, together with all illustrations, can usually be supplied by us. See the "Explanatory Note" at the end, where also the full title of the principal journals indexed are given.

DIVISIONS OF THE ENGINEERING INDEX.

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CIVIL ENGINEERING

BRIDGES.

Anchorage.

The Manhattan Anchorage of Manhattan Bridge. C. M. Ripley. Describes the work of building this anchorage, commenting on the volume of masonry and extensive use of concrete. 2500 w. Munic Engng—June, 1907. No. 85176 C.

Bascule.

Page Single-Leaf Double-Track Bascule Railroad Bridge Over the Chicago River. A. R. Ekstrom. Illustrated description of a bridge replacing a swing bridge, so as to give a clear channel to navigation. 1200 w. R R Gaz—June 14, 1907. No. 85074.

Blackwell's Island.

Progress of the Blackwell's Island Bridge Erection. Information from the official report of May 11, 1907, with illustrated description of recent work. 1600 w. Eng Rec—June 8, 1907. No. 84849.

The Erection of the Western Half of the Blackwell's Island Bridge. Illustrated

We supply copies of these articles. See page 845.

description of work on this bridge across the East River, at New York. 1000 w. Eng Rec—June 15, 1907. No. 85063.

Concrete Arch.

The Piney Branch Concrete Arch Bridge at Washington, D. C. W. J. Douglas and W. P. Darwin. Illustrates and describes the method of laying the arch ring, centering, etc. 1800 w. Eng News—June 20, 1907. No. 85156.

Masonry.

The Queen's Bridge at The Hague (De Witte—Koninginne—brug te's—Gravenhage). F. C. J. van den Steen. An illustrated description of this masonry bridge giving the calculations made in its design. 9000 w. De Ingenieur—May 4, 1907. No. 84989 D.

New York City.

Proposed East River Bridge; New York Connecting Railroad. Illustrations showing the proposed bridge at Ward's and Randall's islands which will join the belt line now building from Bay Ridge on the harbor, with the Harlem River branch of the New York, New Haven, & Hartford. 1200 w. R R Gaz—May 31, 1907. No. 84671.

Plate-Girder.

A Six-Track Solid-Floor Plate-Girder Bridge. Illustrated detailed description of bridge 60 on the main line division of the D. L. & W. R. R. at Scranton, Penna. 2000 w. Eng Rec—June 22, 1907. No. 85198.

Quebec.

The Quebec Bridge Superstructure Details. Illustrated detailed description. 1000 w. Eng Rec—June 22, 1907. Serial. 1st part. No. 85202.

Steel.

The Bridge over the Rhine between Ruhrort and Homburg (Die Straszenbrücke über den Rhein zwischen Ruhrort und Homberg). W. Dietz. The first part of the serial deals principally with the foundations for this steel structure. Ills. 4000 w. Serial. 1st part. Zeitschr d Ver Deutscher Ing—May 11, 1907. No. 84979 D.

The Railway Bridge over the Gorge of the Schwarzwasser (Die Eisenbahnbrücke über das Schwarzwassertobel). Fritz Ackermann. Gives details of this high, long-span, arch bridge. Ills. 1500 w. Schweiz Bau—May 11, 1907. No. 84964 B.

Suspension.

The Bridge "Humbert I" over the Po at Turin (Il Ponte Umberto I sul Po a Torino). F. Corradini. An illustrated description of the design and construction of this suspension bridge. Serial. 1st part. 1500 w. Il Monitore Tech—May 30, 1907. No. 84926 D.

Tubular.

Tubular Bridges. Illustrates and describes famous bridges of this design. 1500 w. Ry & Loc Engng—June, 1907. No. 84772 C.

Viaducts.

Cost of Erecting Three Steel Viaducts of 500 ft., 580 ft., 1170 ft. Length, with Summaries of Costs of Labor and Materials and New Formula for Computing the Weight of Viaducts. 3000 w. Engng-Con—June 19, 1907. No. 85144.

CONSTRUCTION.

Buildings.

The Baltimore & Ohio Office Building, Baltimore. Describes the construction of a 13-story and basement building, giving typical beam plan and details. 3000 w. Eng Rec—June 1, 1907. No. 84703.

Erection of the City Investing Company's Building. Illustrated description of the erection of a 32-sotry steel-cage building in New York City. 2000 w. Eng Rec—June 15, 1907. No. 85055.

The Construction of the Trust Company of America Building, New York. Illustrated description of methods of erection used in advanced fireproof steel cage construction. 3300 w. Eng Rec—June 22, 1907. No. 85205.

The Salvation Army Building, New York. Describes the system of self-supporting reinforcement used in the erection of this fireproof six-story structure. Ills. 1800 w. Eng Rec—June 22, 1907. No. 85203.

Compressed Air.

The Equilibrium of Floating or Immersed Vessels Filled with Compressed Air (Equilibre des Appareils Flottants ou Immergés renfermant de l'Air Comprimé). Edmond Henry. A mathematical discussion referring particularly to caissons, diving bells and other construction devices. Ills. Génie Civil—May 25, 1907. No. 84910 D.

Concrete.

Progress in Construction of Concrete Country Houses. Benjamin A. Howes. Discusses recent applications of this material to the economical construction of attractive and satisfactory homes. Ills. 1800 w. Cement Age—June, 1907. No. 85267 C.

Concrete Pier.

The Cost of a Coffer Dam and Concrete Pier on Pile Foundation. Briefly describes the work, giving analysis of cost. 1400 w. Engng-Con—May 29, 1907. No. 84664.

Contractor's Plant.

The Contractor's Plant and Methods Used on the Minidoka Irrigation Project. Outlines this work in southern Idaho, giving an illustrated description of methods employed. 2800 w. Eng Rec—June 22, 1907. No. 85201.

We supply copies of these articles. See page 845.

Contractors' Plant for Constructing the Reinforced Concrete Warehouse of Montgomery Ward & Co., Chicago, Ill. Illustrated description of a field plant for handling and working up 7,500 tons of reinforcing steel and 4,000,000 ft. B. M. of form lumber, and for mixing and laying 125,000 cu. yds. of concrete. 2200 w. Engng-Con—May 29, 1907. No. 84663.

Fire-Proof.

Fire-Proof Construction. A review of criticisms of experts in recent reports to the Government on the condition of buildings after the San Francisco disaster. 5000 w. Eng Rec—June 15, 1907. No. 85056.

Foundations.

Constructing Elevated Railroad Foundations Over a Large Sewer. Illustrates and describes unusual foundation work in connection with the extension of the New York Rapid Transit Railroad system. 2000 w. Eng Rec—June 8, 1907. No. 84851.

Tall Building Foundations on Soft Clay. Describes tests made preparatory to the erection of the Traders' Bank of Canada, at Toronto, to determine the bearing capacity of the soil. Ills. 1600 w. Eng Rec—June 22, 1907. No. 85200.

The "Compressol" System of Making Foundations. Illustrated description of an improved type of the "Compressol" machine, describing the operation and the process. 1200 w. Engng—June 7, 1907. No. 85114 A.

Foundry Buildings.

The Design and Construction of Foundry Buildings. George K. Hooper. Read before the Am. Found. Assn. Describes some of the plants designed by the author. 4500 w. Eng Rec—June 1, 1907. No. 84704.

House Moving.

Novel House-Moving Operations. Edward H. Crussell. Illustrates and describes method of loading a building on cars, and anchoring to loaded coal cars, for removal along a railway. 1000 w. Sci Am Sup—June 22, 1902. No. 85165.

Levees.

Cost of Riprap Paving, Brush Mattresses and Brush Dikes for a Levee Protection. Gives data of protection work at the West Pass levee in Mississippi. 1100 w. Engng-Con—May 29, 1907. No. 84665.

Planning Works.

The Planning of Contractors' Work. John S. Ely. Discusses the importance of planning to execute the work in the least time at a reasonable cost, illustrating by example. 2000 w. Engng-Con—June 19, 1907. No. 85145.

Reinforced Concrete.

A Reinforced Concrete Laundry Building. Brief illustrated description of a three-story building in Newark, N. J. 900 w. Eng Rec—June 8, 1907. No. 84852.

The Roman Catholic Parish Church in Pressbaum (Die Katholische Pfarrkirche in Pressbaum). Josef Gaugusch. Illustrates and describes details of design and construction of this reinforced concrete structure. Plate. 1500 w. Beton u Eisen—May, 1907. No. 84954 F.

Retaining Walls.

On a More Convenient Section for Retaining Walls (Sul Profilo più Convenienti dei Muri di Sostegas delle Terre). Giulio Stabilini. Mathematical discussion of strength of retaining walls of various sections. Ills. Serial. 1st part. 4000 w. Il Monitor Tech—May 10, 1907. No. 84924 D.

Roads.

General Method of Preparing Plans and Estimates for New York State Highways. Information from a pamphlet issued by the State Engineer. 3300 w. Eng Rec—June 22, 1907. No. 85206.

Rock Drills.

The Rock Drill and Its Share in the Development of New York City. Frank Richards. A fully illustrated article showing the value of the work of the rock drill in New York. 3500 w. Cassier's Mag—June, 1907. No. 85184 B.

Specifications.

The Enforcement of Specifications. Charles B. Dudley. Presidential address before the Am. Soc. for Testing Materials. 9500 w. Ir Age—June 27, 1907. No. 85293.

Trestles.

Hints on the Design and Construction of Wooden Trestles. R. Balfour. Briefly considers the conditions under which the timber has to do its work, and gives designs, discussing their construction. 1200 w. Eng News—June 6, 1907. No. 84814.

Tribune Building.

The Extension of the Tribune Building, New York. An illustrated description of the work of increasing a building from 10 to 20-stories, and the methods of providing for the stresses. 4500 w. Eng Rec—June 1, 1907. No. 84699.

Tunnels.

Driving Concrete Piles Below the Battery Tunnel, New York. Describes the provision made for possible vibrations and abrupt changes of support in the tubes driven under the East River, where they pass through sand. 1600 w. Eng Rec—June 8, 1907. No. 84853.

Grade Correction and Pile Foundations in the East River Tunnel of the New York Rapid Transit Subway. Explains the conditions which led to the use of pile foundations to assure permanent stability, and the method of carrying out the work.

We supply copies of these articles. See page 845.

2000 w. Eng News—June 27, 1907. No. 85303.

The Belmont Tunnel, New York. Describes briefly the construction of the two parallel single-track tunnels under the East River at 42nd St. Ills. 2500 w. Eng Rec—June 8, 1907. No. 84857.

Mining Operations in New York City and Vicinity. H. T. Hildage. A general description of some of the methods and appliances used in the opening-up of a "mine" in a large city, and a brief description of some of the "mines" now being developed in New York. 10500 w. Bul Am Inst of Min Engrs—May, 1907. No. 85272 C.

The Karawanken Tunnel. Illustrates and describes the construction of this tunnel in Austria, especially interesting because of the rapidity of execution. 1200 w. Engr, Lond—May 24, 1907. No. 84759 A.

The Machinery Used in the Construction of the Tauern Tunnel (Die Maschinellen Anlagen beim Bau des Tauerntunnels). K. Brabbée. Illustrated description of drilling machines, pumping plant, power plant, etc. 6500 w. Zeitschr d Ver Deutscher Ing—May 25, 1907. No. 84984 D.

The Boring of the Simplon Tunnel (Come Venne Forato il Sempione). Describes the geology, the drills used, the difficulties encountered, pumping and ventilating arrangements, etc. Ills. 1500 w. L'Elettricità—May 17, 1907. No. 84920 D.

The Construction of the Simplon Tunnel (Der Bau des Simplontunnels). Herr Pressel. A complete description of this work. Ills. Serial. 1st part. 4200 w. Glasers Ann—May 15, 1907. No. 84957 D.

Underpinning.

Cantilever Underpinning in Boston. Illustrates and describes ingenious cantilever underpinning with suspended fulcrums, used in the construction of the Boston Transit Commission's subway. 1000 w. Eng Rec—June 15, 1907. No. 85057.

MATERIALS OF CONSTRUCTION.

Asbestos Wood.

Fire Test of Asbestos Wood. C. L. Norton. Illustrated account of test, proving the excellence of its non-conducting and non-radiating properties. 1000 w. Ins Engng—June, 1907. No. 85195 C.

Cement.

Cement for Building Construction. Report of the Committee of the National Fire Protection Association. 5500 w. Eng Rec—June 8, 1907. No. 84856.

A Review of the Chemistry of Portland Cement. F. H. Mason. Outlines the method of manufacture, and reviews the researches of M. Le Chatelier in regard to the setting and hardening of cement. 2000 w. Min & Sci Pr—June 8, 1907. No. 84864.

Recommendations for the Uniform Supply and Testing of Portland Cement (Bestimmungen für die Einheitliche Lieferung und Prüfung von Portland-Zement). Report of a Committee of the Austrian Society of Engineers and Architects, giving recommendations for standard sizes and weights of packages and tests. 3000 w. Zeitschr d Oest Ing u Arch Ver—May 17, 1907. No. 84973 D.

Concrete Pipes.

Processes and Machines for the Production of Reinforced-Cement Poles and Pipes (Verfahren und Maschine zur Erzeugung von Armierten Zement-Masten und -Röhren). Hans Siegwart. Ills. Serial. 1st part. 1400 w. Beton u Eisen—May, 1907. No. 84955 F.

Fire Protection.

Concrete and Reinforced Concrete Construction from the Fire Protection View. Report of the Committee on "Cement for Building Construction" of the Nat. Fire Protection Assn. 4000 w. Eng News—June 6, 1907. No. 84817.

Hydraulic Cements.

The Hardening Process in Hydraulic Cements (Ueber die Erhärtungsprozesz der Hydraulischen Bindemittel). Dr. Rohland-Stuttgart. Treats the subject from the standpoint of physical chemistry. 2800 w. Stahl u Eisen—May 8, 1907. No. 84938 D.

Reinforced Concrete.

The Corrosion of Steel in Reinforced Cinder Concrete. William H. Fox. A report of experiments with a statement of conclusions. 1500 w. Eng News—May 23, 1907. No. 84859.

Statical Investigation of a Constantly-Recurring Problem in Reinforced-Concrete Construction (Statische Untersuchung einiger im Eisenbetonbau häufig Vorkommenden Aufgaben). Charles Abeles. Mathematical paper on the strength of reinforced-concrete beams. Serial. 1st part. 2000 w. Beton u Eisen—May, 1907. No. 84956 F.

Silt.

The Applicability to India of the Italian Method of Utilizing Silt. Sir Edward Charles Buck. Explains what India has done to utilize silt, and describes what Italy has done, suggesting further possibilities for India. 13500 w. Jour Soc of Arts—May 31, 1907. No. 84869 A.

Slag Cement.

Recommendations for the Uniform Supply and Testing of Slag Cement (Bestimmungen für die Einheitliche Lieferung und Prüfung von Schlacken-Zement). Report of a Committee of the Austrian Society of Engineers and Architects, giving recommendations for standard sizes

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and weights of packages and tests. 3000 w. Zeitschr d Oest Ing u Arch Ver—May 24, 1907. No. 84974 D.

Specifications.

Concerning Bridge Steel and Ship Steel. Editorial urging the unification of specifications for structural steel. 1000 w. Eng News—June 6, 1907. No. 84818.

MEASUREMENT.

Beams.

The Point of Economy in the Design of Reinforced-Concrete Beams. Editorial on the paper of F. W. Hanna, and letter by P. L. Reed, with curves and discussion with conclusions. 3500 w. Eng News—June 20, 1907. No. 85158.

Bending Moments.

Analytical Investigation of the Maximum Bending Moment in Steel Bridges (Investigaciones Analiticas sobre el Momento Máximo de Flexión en Puentes Ferroviarios). C. W. Ljungstedt. Mathematical paper with diagrams. Serial. 1st part. 3000 w. Ingenieria—April 15, 1907. No. 84928 D.

Moving Loads on Railway Under-Bridges. H. Bamford. Considers analytical versus graphical methods of determining the maximum bending moment and shear due to a train-load. 2500 w. Engng—May 31, 1907. No. 84890 A.

Cantilevers.

Influence Lines for Suspended Cantilevers. Myron S. Falk. General deductions as to the determination of the statical condition of such structures, and the application of influence lines to determine the maximum stresses. 3000 w. Sch of Mines Qr—April, 1907. No. 85020 D.

Centre of Gravity.

Investigation of More General Formulæ for Centres of Gravity and Moments of Inertia (Indicación de una Fórmula la más General para los C de G; para los M de I). J. Gali. Mathematical paper illustrated by diagrams. 7000 w. Revista Tech Ind—April, 1907. No. 84929 D.

Leveling.

Precision Leveling in the Argentine Republic (La Nivelación de Precisión en la República Argentina). Arduino Lelli. Reviews the history of precision leveling and discusses the theory, errors, results obtained in Argentina, etc. Serial. 3 parts. 20000 w. Anal Sociedad Cien Argen—Sept., Oct., and Nov., 1906. No. 84931 each F.

Recording Extensometer.

An Extensometer for Recording Deformations in Bridge Members Under Impact Stress. Illustrated detailed description of an autographic instrument devised by F. E. Turneaure. 1200 w. Eng News—June 20, 1907. No. 85155.

Surveying.

Difficulties Encountered in Early Surveys of the State of Massachusetts; How They Were Overcome and the Results Obtained. Frank W. Hodgdon. 5000 w. Jour Assn of Engng Socs—May, 1907. No. 85143 C.

Photographic Surveying. William Griffith. An illustrated explanation of a method of making topographic surveys and maps of a region from a series of photographs. 1000 w. Mines and Min—June, 1907. No. 84739 C.

Two-Hinged Arches.

The Two-Hinged Arch with Tie Rod (Der Zweigelenkbogen mit Zugband in Beliebiger Höhe). F. Bohny. An elaborate, mathematical analysis of the stresses in this type of truss. Ills. 10000 w. Serial. 1st part. Zeitschr d Ver Deutscher Ing—No. 84978 D.

MUNICIPAL.

Fire Protection.

Fires in Cotton-Mills; Their Prevention and Extinction. The causes of fires are considered and suggestions for fire fighting. Ills. 2000 w. Engng—May 31, 1907. No. 84891 A.

Pavements.

Brick Pavements. Presents some of the advantages of brick pavements and gives illustrations of streets in various cities. 1300 w. Munic Engng—June, 1907. No. 85178 C.

Recent Progress in the Asphalt Paving Industry. Abstract of a recent paper by Clifford Richardson, reviewing the development of sheet asphalt paving, and discussing the principles upon which good construction is based, the materials, and recent improvements. 5700 w. Eng Rec—June 1, 1907. No. 84701.

Tar Macadam Pavement in Duluth, Minn. E. K. Coe. A description of the methods used, and report of the satisfactory results. 2800 w. Eng News—May 30, 1907. No. 84697.

The Development of Street Pavements. George W. Tillson. A study of the causes that led to the use of the different materials and the changes adopted. Ills. 5000 w. Jour Fr Inst—June, 1907. No. 85138 D.

How to Compute the Cross-Section of a Curved Street Paving. Analysis and practical application of method. 500 w. Engng-Con—June 12, 1907. No. 85034.

Public Health.

The Spreading of Diseases by Insects and Their Extermination (Die Uebertragung von Krankheiten durch Insekten und ihre Bekämpfung). Claus Schilling. 3000 w. Gesundheits-Ing—May 11, 1907. No. 84969 D.

Refuse Disposal.

English, German, and Swiss Destructor

We supply copies of these articles. See page 845.

Plants. Frank C. Perkins. An illustrated article describing these plants and the use made of the power. 2500 w. Munic Engng—June, 1907. No. 85177 C.

Disposal of House Refuse. Illustration and description of the "Lightning" refuse disintegrator, its operation and cost of treatment. 800 w. Engng—June 7, 1907. No. 85117 A.

Roads.

Tar-Spreading Tests. Reports a series of tests of machines designed for this work to determine their efficiency and cost of operation. Ills. 3000 w. Engr, Lond—May 4, 1907. No. 84761 A.

The Dust Prevention Competition. A report of the practical tests in England of roads treated by tar-spraying machines, and of the competing machines. Ills. 2500 w. Autocar—June 1, 1907. No. 84873 A.

Sewage.

The Comparative Disposition of Organic Matter by Sand, Contact and Sprinkling Filters. H. W. Clark. Abstract of a paper read before the Am. Pub. Health Assn., City of Mexico. A study of the organic matter in suspension in sewage. 4500 w. Eng News—June 6, 1907. No. 84813.

Hanley Sewage Works. Gives an outline of recently completed works said to be the most perfect sewage scheme ever put in operation. 1500 w. Engr, Lond—May 31, 1907. No. 85001 A.

Sewers.

Cost of Trenching, Pipe-laying and Backfilling for Sanitary Sewer Construction at Centerville, Iowa. Gives table showing the man hours and unit cost for each job separately. 1200 w. Engng-Con—June 12, 1907. No. 85035.

WATER SUPPLY.

Bore Holes.

Determining the Direction of Deep Bore Holes and Testing Their Water Tightness. Illustrates and describes an instrument devised by John J. Horan for use in connection with the work of building the great aqueduct that is to carry additional water to New York City. 800 w. Eng News—May 23, 1907. No. 84858.

Dam.

Cataract Dam, New South Wales. Brief illustrated description of the largest dam in Australia. 2500 w. Aust Min Stand—May 1, 1907. No. 84870 B.

Filtration.

Modern Tendencies in Filtration. George C. Whipple. Brief consideration of the latest theories, sand filters, mechanical filters, preliminary treatment, etc. 18000 w. Munic Jour & Engr—June 5, 1907. No. 84768 C.

The Filtration of Water at Bolton. L. Mitchell. General remarks on the progress of filtration methods and the efficiency of slow sand filters, with illustrated description of the mechanical filters at the Bolton water-works, stating their advantages. 4000 w. Engng—June 7, 1907. No. 85112 A.

The Slow-Sand Filtration Plant and Other Water-Works Improvements at Denver, Colorado. Illustrates and describes important changes recently made to the system, including three new filters, a system of underground wooden galleries, pumping plant, etc. 3000 w. Eng Rec—June 22, 1907. No. 85204.

The Water Filtration Plant at Moline, Ill. Illustrated description of a plant with a normal capacity of 5,000,000 gal. in 24 hours. 4800 w. Eng Rec—June 15, 1907. No. 85058.

Irrigation.

Irrigation Colonies in India. Laurence Robertson. Deals especially with the methods adopted for peopling these tracts. Discussion. 13800 w. Jour Soc of Arts—June 14, 1907. No. 85232 A.

Mains.

Testing with a Scraper for Obstructions in a Long Water Main. Extract from a paper by R. H. Dorman, describing the passing of a scraper through the whole length of a pipe laid in Ireland, to make sure that no obstructions existed which might interfere with the flow. 1500 w. Eng News—May 30, 1907. No. 84698.

Massachusetts.

The Metropolitan Water-Works System of Massachusetts. Caleb Mills Saville. Reviews the history, giving an account of the organization and description of the works. 2500 w. Munic Engng—June, 1907. No. 85175 C.

Pollution.

The Detection of Pollution in Underground Waters, and Methods of Tracing the Source Thereof. John C. Thresh. Before the Assn. of Water Engrs. Reports utility tests made by the use of salt, fluorescin, and other substances. 5000 w. Engr, Lond—June 14, 1907. No. 85249 A.

Some Relations of Stream Pollution and Water Purification. Charles Carroll Brown. Discusses the problems of stream pollution and the legal limitations; the legislation in various countries, and various parts of the United States; the damage to water supplies; the sources of water supply and the purification of water, etc. 9000 w. Wis Engr—June, 1907. No. 85128 D.

The Work of the Ohio State Board of Health on Water Supply and Sewage Disposal. R. Winthrop Pratt. An outline of the work in connection with pollution, its

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prevention and rectification. 2800 w. Eng News—June 20, 1907. No. 85154.

Pumping Engines.

See Mechanical Engineering, Hydraulics.

Pumping Stations.

The Pelham Pumping Station of the New Rochelle Water Co. Illustrated description of a small station to supplement a gravity supply. 1200 w. Eng Rec—June 15, 1907. No. 85059.

High-Pressure Fire-Service Pumping Station at Coney Island. B. Franklin Hart, Jr. Illustration, with description of the station and report of tests. 2000 w. Stevens Ind—April, 1907. No. 85124 D.

Rates.

Rates for Water Service. Dabney H. Maury. Presidential address before the Am. Water-Works Assn. Outlines the principles which should govern the determination of the fair rate. 1500 w. Eng. News—June 27, 1907. No. 85301.

Reservoirs.

The Settling Reservoirs of the New Cincinnati Water-Works. William C. Jewett. Illustrated detailed description of the construction of these reservoirs. 2500 w. Eng Rec—June 8, 1907. No. 84850.

Sluicing Gates.

Large Electrically Operated Gates for the Roosevelt Dam, U. S. Reclamation Service. F. W. Hanna. Illustrated detailed description of the gates to be installed, which are the largest in the world operated under the pressure to which they will be subjected. 2700 w. Eng News—May 30, 1907. No. 84696.

Wells.

Water Supplies by Means of Artesian Bored Tube-Wells. Herbert F. Broadhurst. Read before the Inst. of Min. Engrs. Describes methods used in boring artesian tube-wells, and for their protection, testing and pumping. 4000 w. Ir & Coal Trds Rev—June 14, 1907. No. 85251 A.

WATERWAYS AND HARBORS.

Canals.

The Somersetshire Coal Canal. Illustrates and describes this old canal in England. It is to become the site of a single line railway for the Great Western system. 1500 w. Engr, Lond—May 24, 1907. No. 84760 A.

Floods.

Flood Protection in Ithaca, N. Y. Describes conditions at this city on Cayuga Lake, and the means taken to confine Six Mile Creek to a safe channel. Ills. 2200 w. Eng Rec—June 8, 1907. No. 84855.

Mersey.

The Mersey Channel. Illustrated description of proposed work to deepen the entrance channel. 400 w. Engr, Lond—June 14, 1907. No. 85247 A.

Panama.

The Isthmian Canal—A General Résumé of the Work Accomplished. F. B. Maltby. 10500 w. Pro St Louis Ry Club—May 10, 1907. No. 85044.

The Panama Canal and Conditions in the Canal Zone. O. L. Whitelaw. Impressions from a trip to the isthmus. Ills. 5500 w. Pro St Louis Ry Club—May 10, 1907. No. 85045.

The Preparatory Period, Panama Canal. Gen. Henry L. Abbot. Gives a brief summary of events since the United States obtained control, and discusses matters of technical interest having a bearing upon the project. 3500 w. Harvard Engng Jour—June, 1907. No. 85191 D.

Parana.

The Artificial Canalization of the Rio de la Plata (Canalización Artificial del Rio de la Plata). Augustin Mercau. A discussion of the project for a ship canal from Buenos Ayres to Paraná de las Palmas, giving costs, etc. Plate. 11000 w. Anal Sociedad Cien Argen—Dec., 1906. No. 84932 F.

Salton Sea.

Colorado River Crevasse and Salton Sea. H. T. Cory. An illustrated account principally devoted to the work of closing the second break. Especially considers the effect on the railway lines of the Southern Pacific. 2500 w. Ry Age—June 14, 1907. No. 85085.

Seville.

The Port of Seville. Mateo Clark. Reviews the history of this port and improvements made in the Guadalquiver River between Seville and the ocean, describing proposed new works. 2000 w. Engng—June 14, 1907. No. 85245 A.

ELECTRICAL ENGINEERING

COMMUNICATION.

Cables.

The Pupin Telephone Cable Across Lake Constance. Gives an account of the difficulties experienced in manufacturing and laying a cable with Pupin coils, and compares the results with ordinary telephone cables. 3000 w. Elect'n, Lond—May 24, 1907. No. 84753 A.

Printing Telegraphs.

Keyboard Page-Printing Telegraphs. Romyn Hitchcock. Discusses the advan-

tages claimed for typewriter keyboard printers, considering especially the Rowland multiplex printing telegraph and the telegraphic typewriter invented by J. E. Wright. 2500 w. Elec Rev, N Y—June 1, 1907. No. 84716.

Radiotelegraphy.

An Ungrounded, Closed Circuit for Receiving Wireless Signals. Greenleaf W. Pickard. Describes an interesting system, giving some details of the method of adjusting it and some results of tests. 1200 w. Elec Rev, N Y—June 15, 1907. No. 85069.

Recent Contributions to Electric Wave Telegraphy. Prof. J. A. Fleming. Presented before the Roy. Inst. of Gt. Britain. The present number considers effects of electric wave telegraphy which can be measured. 3000 w. Elect'n, Lond—May 31, 1907. Serial. 1st part. No. 84887 A.

Recent Developments in Wireless Telegraphy. Dr. Lee de Forest. A brief review of the rapid development of this science, recent advances and problems yet to be solved. 3500 w. Jour Fr Inst—June, 1907. No. 85139 D.

The Commercial Future of Wireless Telegraphy. E. Millian Trinks. Considers in detail the factors affecting the ultimate commercial value. 1200 w. Elec Rev, N Y—June 1, 1907. No. 84714.

Sound.

Some Observations on Sound. George Sherwood Hodgins. A study of the degree of loudness and pitch of tones produced both mechanically and electrically. 2300 w. Ry & Loc Engng—June, 1907. No. 84776 C.

Telegraph Receiver.

The Creed Receiving Telegraph Perforator. A perforating receiver which has been in successful operation for two years is illustrated and described. 1200 w. Elec Rev, Lond—June 14, 1907. No. 85237 A.

Telegraphy.

Telegraph Switching: Metropolitan Intercommunication Scheme. An illustrated article discussing a system to meet the requirements of Greater London. 700 w. Elec Rev, Lond—May 24, 1907. Serial. 1st part. No. 84747 A.

Telephone Relays.

Telephone Relays (Le Relais Téléphonique). M. Henry. A review of the development of the telephone relay and a discussion of its present status. Ills. 3500 w. Soc Belge d'Electriciens—May, 1907. No. 84916 E.

Telephony.

Inductive Disturbances in Telephone Line. Louis Cohen. Discusses the question from a mathematical standpoint, showing that not only is the electromagnetic induction not a negligible quantity, but that in some cases its effect may be much larger than the electrostatic effect. Considers the results obtained by J. J. Carty. 2000 w. Pro Am Inst of Elec Engrs—May, 1907. No. 85285 D.

DISTRIBUTION.

Dangers.

Hygienic Aspects of Interior Uses of Electricity (Zur Hygiene der Elektrischen Hauseinrichtungen). S. Jellinek. Discusses the various sources of danger in the use of electricity, giving numerous examples. 6000 w. Serial, 2 parts. Der Elektrotechniker—May 10 and 25, 1907. No. 84966 each D.

Losses.

An Analysis of the Distribution Losses in a Large Central Station System. Abstract of a paper by L. L. Elden, presented before the Boston branch of the Am. Inst. of Elec. Engrs. 2000 w. Elec Wld—June 22, 1907. No. 85227.

Theatres.

Rules Governing the Installation of Theatre Wiring. Gives the suggested "Special Rules and Requirements for the Installation of Wires and Apparatus for Electric Light, Heat and Power in Theatres Where Potential of System Does Not Exceed 250 Volts" as recommended by the committee appointed by the Nat. Bd. of Fire Underwriters. 2500 w. Elec Wld—June 8, 1907. No. 84846.

Wiring.

Wiring Plans for Heating Devices. F. M. Feiker. Briefly explains the three general plans in use for wiring houses, giving a résumé of the Nat. Elec. Code rules governing the installation of heating devices, and gives details of houses illustrating the different systems. Ills. 2000 w. Elec Rev, N Y—June 1, 1907. No. 84718.

DYNAMOS AND MOTORS.

Design.

The Mechanical Design of a Standard Line of Electric Motors. Hal Luckin. Enumerates the points which should not be overlooked. 2000 w. Elec Rev, Lond—May 24, 1907. No. 84749 A.

Induction Motors.

Polyphase Induction Motors. Robert D. Archibald. Abstract of a paper read before the Birmingham and District Electric Club. Describes the action, construction and possibilities of two- and three-phase induction motors. 3500 w. Elec Engr, Lond—May 24, 1907. No. 84746 A.

The Estimation of Starting Resistances for Three-Phase Induction Motors. D. A. Trickett. Describes the lines upon which the resistances of such machines may be estimated in design. 1200 w. Elec Rev, Lond—May 24, 1907. No. 84748 A.

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Interpoles.

The Present State of Direct-Current Design as Influenced by Interpoles. F. Handley Page and Fielder J. Hiss. A statement of the present condition of direct-current design, showing how it has been affected by the interpole machine which ensures a more efficient ventilation, lower first cost due to saving in material, and improved efficiency. 8500 w. Inst of Elec Engrs—May 23, 1907. No. 85-036 N.

Single Phase.

The Vector Diagram of the Compensated Single-Phase Alternating-Current Motor. W. I. Slichter. An analysis of the character and cause of the reactions effecting the efficiency and power-factor. 1000 w. Pro Am Inst of Elec Engrs—May, 1907. No. 85284 D.

The Construction and Application of the Serviceable Single-Phase Motor (Die Bauart und Verwendung der praktisch Brauchbaren Einphasen-Wechselstrommotoren). A. Linker. Ills. Serial. 2 parts. 5000 w. Elektrotech u Polytech Rundschau—May 8 and 15, 1907. No. 84951 each D.

Speed Regulation.

Notes on Speed Regulation of Direct-Current Motors Under Different Conditions of Working. J. W. Rogers. A brief review of the methods used in present-day practice to obtain variations in speed over a wide range, without detracting from the efficiency of the system. Serial. 1st part. 2300 w. Prac Engr—June 7, 1907. No. 85095 A.

Motor Control. Describes a patent granted to V. A. Fynn relating to means for operating single-phase motors having a shunt characteristic at any desired speed independently of the periodicity of the supply and the number of poles of the motor. 700 w. Elec Engr, Lond—June 7, 1907. No. 85100 A.

Synchronous Motors.

Synchronous Motor Problems. H. H. Norris. Gives a study of the Metropolitan Alternator in the power house of the New York City Railway Co. 1700 w. Sib Jour of Engng—June, 1907. No. 85135 C.

Turbo-Alternator.

Willans-Dick-Kerr 2000-KW. Turbo-Alternator for Sydney. Illustrated detailed description of both the turbine and alternator. 3000 w. Elec Engr, Lond—June 7, 1907. No. 85098 A.

ELECTRO-CHEMISTRY.

Alkali Works.

The New Electrolytic Alkali Works at Niagara Falls. Extracts from a paper by Dr. L. H. Backeland on the Townsend cell, which has been in successful use for a year in Niagara Falls. Also editorial. Ills. 3000 w. Elec-Chem & Met Ind—June, 1907. No. 84778 C.

Electric Furnace.

The Economic Status of the Electric Furnace. Wilder D. Bancroft. Considers some of the advantages of the electric furnace, the nature of the competition it has to face, the products manufactured, illustrating points in which electricity is superior to other forms of heating. 2000 w. Sib Jour of Engng—June, 1907. No. 85136 C.

Electro-Plating.

Electro Deposition of Brass. Charles H. Proctor. Read before the Am. Found. Assn. Suggestions for producing deposits of alloys. 1000 w. Ir Age—June 6, 1907. No. 84734.

Nitric Acid.

The Electrochemical Production of Nitric Acid from the Air (La Fabrication Electrochimique de l'Acide Nitrique à l'Aide des Eléments de l'Air). Jean Escard. A review of the investigations on this subject with descriptions of the processes employed. Ills. 8000 w. Soc Belge d'Electriciens—May, 1907. No. 84915 E.

Ozone.

Industrial Application of the Electrical Discharge (Aplicación Industrial del Efluvio Eléctrico). F. M. Fernández. Discusses the various applications of ozone in the purification of water, in chemistry and in the sugar industry. Ills. 5000 w. Energia Eléctrica—May 25, 1907. No. 84927 D.

Storage Batteries.

Storage Batteries. V. Karapetoff. Explains the properties of storage batteries and the advantages from their use. Describes their construction and chemical action, and method of testing. Ills. 2800 w. Elec Jour—June, 1907. Serial. 1st part. No. 85131.

ELECTRO-PHYSICS.

Electrons.

The Properties of Electrons. Samuel Sheldon. Presidential address. An explanation of electrons and their physical properties, and their effects when in motion. 8000 w. Pro Am Inst of Elec Engrs—May, 1907. No. 85276 D.

Electrons (Sur les Electrons). H. Becquerel. Mathematical and theoretical discussion of the electron theory, reviewing the work of the leading investigators of the subject. Ills. 5600 w. Bull Soc In d' Electriciens—May, 1907. No. 84,913 F.

Electrons (Los Electrones). Julio J. Gatti. A general review of the electron theory. 9000 w. Anal Sociedad Cien Argen—Aug., 1906. No. 84930 F.

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Magnetism.

Critical and Supplementary Notes on the Theory of the Magnetism of Iron (Kritische Betrachtungen und Ergänzungen zur Theorie des Ferromagnetismus). R. Gans. Theoretical and mathematical discussion of the accepted formulæ. Diagrams. 5500 w. Elektrotech Zeitschr—May 23, 1907. No. 84987 B.

On the Law of Magnetic Attraction at a Distance and Its Applications (Loi d'Attraction Magnétique à Distance et ses Applications). R. V. Picou. A theoretical, mathematical discussion with examples showing the importance of further knowledge. Ills. 3500 w. Bull Soc Int d'Electriciens—May, 1907. No. 84914 F.

Resistance.

The Variation of Manganin Resistance with Atmospheric Humidity. E. B. Rosa and H. D. Babcock. Read before the Am. Phys. Soc. It has been noticed that manganin resistances change their value regularly with the time of year. Shows that this change is due to variations of humidity. 2800 w. Elect'n, Lond—June 14, 1907. No. 85240 A.

Wave Distortion.

Distortion of Alternating-Current Waves due to the Presence of Iron (Deformazioni d'Ouda delle Correnti Alternate per la Presenza del Ferro). Theoretical discussion illustrated by numerous curves. 1500 w. L'Elettricità—May 24, 1907. No. 84921 D.

GENERATING STATIONS.

Balancers.

Static Balancers. Charles C. Garrard. Gives a general description of the apparatus with a diagram illustrating the system, discussing it in detail, and describing its advantages. 2300 w. Elec Rev, Lond—June 14, 1907. Serial. 1st part. No. 85239 A.

Coal Handling.

Coal Handling and Condensing Equipment in the Gold Street Station of the Edison Electric Illuminating Company of Brooklyn. An illustrated description of the condensing apparatus and coal and ash handling machinery. 3500 w. Elec Wld—June 15, 1907. No. 85071.

England.

The Windsor, Slough, and Datchet Electricity Supply Undertakings. Reviews the main features of the undertakings, describing the machinery used in the different stations, and showing the progress. 1000 w. Elec Engr. Lond—June 7, 1907. Serial. 1st part. No. 85099 A.

Government Buildings.

Electricity in the Government Buildings in Washington, D. C. Illustrated description of the present electrical equipments of the government buildings and the uses to which electricity is applied, with an account of a proposed central station to supply current. 5000 w. Elec Wld—June 8, 1907. No. 84847.

New Power Plant for Legislative Group of Buildings in Washington, D. C. Short illustrated description of a central plant to supply electricity for a group of buildings on Capitol Hill. 1000 w. Elec Wld—June 1, 1907. No. 84848.

Hydro-Electric.

The Development of the McCall's Ferry Power Company. Day Allen Willey. An illustrated outline of this project for utilizing the water of the Susquehanna River. The dam under construction is one of the most extensive in the world. 2000 w. Elec Rev, N Y—June 1, 1907. No. 84717.

The Hydro-Electric Plant at Trezzo d'Adda (L'Impianto Idroelettrico di Trezdo d'Adda). An illustrated description of one of the largest Italian plants. 1500 w. L'Elettricità—May 10, 1907. No. 84919 D.

The Generating Station at Beznau, Switzerland (Usine Electrique de la Beznau, Suisse). P. Chignaterie. An illustrated description of the hydraulic, steam and electrical equipment of this hydro-electric plant on the Aar which has a subsidiary steam-turbine installation. 2000 w. Génie Civil—May 4, 1907. No. 84906 D.

Municipal Plant.

The Cleveland Municipal Electric Lighting Plant. Illustrated detailed description of a new plant in service since March. 1500 w. Elec Rev, N Y—June 15, 1907. No. 85070.

Portland, Ore.

The Water and Electric Power Systems of the Portland Railway Light and Power Company, Portland, Oregon. W. P. Hardesty. An illustrated article describing briefly the older portions of this system, and in detail, the latest addition. 7000 w. Eng News—June 27, 1907. No. 85209.

Rates.

The Principles of Modern Rate-Making for Electric Light and Power. Gives an analysis of the cost of supplying different classes of business, and explains several systems in use. 6000 w. Elec Wld—June 1, 1907. No. 84723.

Methods of Computing Central Station Rates in Boston. An explanation of the method of computing rates used by the Edison Electric Illuminating Company. 2000 w. Elec Wld—June 1, 1907. No. 84724.

The Present Tendency of Charging for Electricity. W. A. Toppin. Remarks on the many changes being made in the system of charging in English towns, and suggests that an effort be made to secure

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uniformity. 1500 w. Elec Rev, Lond—June 7, 1907. No. 85104 A.

Safety.

Security from Fire and Danger to Life in Electrical Plants (Die Sicherheit Elektrischer Anlagen bezüglich Feuer und Leben). G. Dettmar. Conclusions based on the experiences of German fire-insurance companies. Tables. 4400 w. Elektrotech Zeitschr—May 30, 1907. No. 84988 B.

Transformers.

Protection of the Internal Insulation of a Static Transformer Against High-Frequency Strains. Walter S. Moody. Introductory to a general discussion. Explains how a theory that very little preventive reactance is necessary to protect the winding of a transformer whose outer turns are heavily insulated has been carried out and tested on a large scale. Ills. 1000 w. Pro Am Inst of Elec Engrs—May, 1907. No. 85278 D.

Choke-Coils versus Extra Insulation on the End-Windings of Transformers. S. M. Kintner. Introductory to a general discussion. States the advantages and disadvantages of separate choke-coils. 1200 w. Pro Am Inst of Elec Engrs—May, 1907. No. 85277 D.

United States.

Central Stations in the United States (Elektrische Centralen in de Vereenigde Staten). Th. E. Maltha. Describes several large steam-driven power plants in and about New York, Boston and Chicago, giving details of equipment. Ills. 9000 w. De Ingenieur—May 25, 1907. No. 84992 D.

Washington, D. C.

Electricity in Washington, D. C., and Its Environs. An illustrated outline of some of the more important electrical developments. 2000 w. Elec Rev, N Y—June 1, 1907. No. 84713.

Generating Stations and Sub-Stations of the Potomac Electric Power Company, Washington, D. C. An illustrated historical review of electric lighting at the capital of the United States, describing the present stations. 7000 w. Elec Wld—June 1, 1907. No. 84721.

LIGHTING.

Arc Lamps.

New Developments in Arc Lamps and High-Efficiency Electrodes. George M. Little. Read before the Nat. Elec. Lgt. Assn. Deals with magnetite electrodes and a lamp suitable for using them. 2500 w. Elec Rev, N Y—June 15, 1907. No. 85068.

The Beck Flame Arc Lamp. Illustrated description of an arc lamp in which the carbons descend by gravity as they are consumed. 1500 w. Elec Engr, Lond—May 24, 1907. No. 84745 A.

Exposition.

Lighting of the Jamestown Ter-Centennial Exposition. An illustrated description of the lighting of the exhibition buildings and grounds. Also of the electric service plant. 2000 w. Elec Wld—June 1, 1907. No. 84722.

Filaments.

The Temperature and Emissivity of Carbon, Osmium, and Tungsten Filaments. A. Grau. Abstract translation from *Elektrotechnic und Maschinenbau.* A report of experimental investigations. 1200 w. Elect'n, Lond—June 7, 1907. No. 85107 A.

Mercury Vapor.

The Mercury Vapor Lamp (La Lampe à Vapeur de Mercure). M. de Recklinghausen. Gives a sketch of the development of the Cooper-Hewitt lamp, describes its construction and operation, and compares it with other types of lamps. Ills. 3700 w. Bull Soc d'Encour—April, 1907. No. 84900 G.

Problems.

The Problem of Illumination. Joseph H. Hart. Briefly considers the problems of light production. 2000 w. Cassier's Mag—June, 1907. No. 85180 B.

Wind Power.

Domestic Electric Light Plant Driven by a Windmill. Illustrations, with short description of a successful plant at Noblesville, Ind. 400 w. Sci Am—June 1, 1907. No. 84673.

MEASUREMENT.

Capacity.

Measurement of the Resistance of Insulation and the Capacity of the Separate Wires of an Alternating-Current Circuit during Working (Messung des Isolationswiderstandes und der Kapazität der Einzelnen Leiter von Wechselstrom-Anlagen während des Betriebes). Johann Sahulka. Diagrams. 6000 w. Serial. 2 parts. Elektrotech Zeitschr—May 2 and 9, 1907. No. 84985 each B.

Electrical Units.

Electrical Laws and Units. Explains the meaning of the fundamental electrical units in common use. 1000 w. Ry & Loc Engng—June, 1907. No. 84775 C.

Illumination.

Measurement of Instantaneous Values of Electric Lights on Alternate Current. Dr. Johann Sahulka. Abstracted from *Elektrotechnik und Maschinenbau.* Describes methods proposed by the writer, and apparatus used. 1500 w. Elect'n, Lond—May 31, 1907. No. 84886 A.

On the Determination of the Mean Horizontal Intensity of Incandescent Lamps. Edward P. Hyde and F. E. Cady. Discusses the error due to flicker in lamp testing, giving recent investigations, the methods and results. 4000 w. Elec Wld—June 22, 1907. No. 85226.

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Insulators.

A Test of Insulators for an Exceptional Service. Sidney Sprout. States the exceptional conditions to be met, describing the testing and giving results. Ills. 2500 w. Elec Ry Rev—June 15, 1907. No. 85079.

Leakage.

Simple Zero Methods for the Direct Determination of Leakage Factors. Dr. R. Pohl. Considers simple direct methods, referring to R. Goldschmidt's method, and two methods which give accurate results, and can be used with ordinary testing instruments. 1600 w. Elect'n, Lond—May 24, 1907. No. 84751 A.

Meters.

A New Type of Graphic Recording Meters. H. W. Young. Illustrates and describes a new type of meter which makes a record on a continuous roll of paper ruled with rectangular co-ordinates. 2500 w. Elec Rev, N Y—June 1, 1907. No. 84719.

Motor Testing.

Economical Testing of Generators and Motors. J. Lewis Cook. Briefly considers methods of testing D. C. machines in which the power developed by the machine under test is partly used to drive it. 1500 w. Elec Rev, Lond—June 7, 1907. No. 85102 A.

Oscillograph.

On Recording Transitory Electrical Phenomena by the Oscillograph. J. T. Morris. Describes the writer's use of the falling plate type of oscillograph. Diagrams. 1500 w. Elect'n, Lond—June 7, 1907. No. 85105 A.

Photometry.

The Speed of Flicker Photometers. J. S. Dow. Investigates the connection between the sensitiveness of a flicker photometer and the speed at which the flicker disc is driven. 1800 w. Elect'n, Lond—May 31, 1907. No. 84884 A.

Testing Plant.

The Arrangements of the Testing Station at Frankfurt (Die Einrichtungen des Elektrischen Prüfamtes in Frankfurt). Rudolf Kopp. Describes an elaborate plant for the testing of electric machinery and apparatus. Ills. 7000 w. Serial. 2 parts. Elektrotech Zeitschr—May 16 and 23, 1907. No. 84986 each B.

Transformer Testing.

Loading Stationary Induction Apparatus for Heat Tests. George C. Shaad. Describes testing transformers in pairs, and in threes, testing feeder regulators, and induction regulators. Diagrams. 1200 w. Elec Jour—June, 1907. No. 85132.

Wattmeters.

Hot-Wire Wattmeters and Oscillographs. J. T. Irwin. Describes a new type of polarized hot-wire instrument invented by the author, and some of the uses to which it can be applied. 7500 w. Inst of Elec Engrs—May 23, 1907. No. 85037 N.

TRANSMISSION.

Direct Current.

High-Pressure D. C. Transmission. Calls attention to some things to be considered in connection with the series system of direct-current power transmission. 1600 w. Elec Rev; Lond—June 7, 1907. No. 85103 A.

Economics.

Some Power Transmission Economics. Frank G. Baum. Illustrates and describes examples of line and switch construction to show that the best solution of a problem is the one which accomplishes the purpose satisfactorily with the least amount of money, on account of changes in design which become apparent as the industry develops. 1600 w. Pro Am Inst of Elec Engrs—May, 1907. No. 85283 D.

Lightning Protection.

Lightning Rods and Grounded Cables as a Means of Protecting Transmission Lines Against Lightning. Norman Rowe. Introductory to a discussion. A summary of lightning troubles during the years 1904, 1905, and 1906, on a steel tower, long span transmission line in Mexico. Ills. 2200 w. Pro Am Inst of Elec Engrs—May, 1907. No. 85280 D.

A Permanent-Leak Water Lightning Arrester. Lewis W. Dixon. Illustrated description of a water lightning arrester, recently erected in Wales. 700 w. Elect'n, Lond—May 24, 1907. No. 84752 A.

Line Troubles.

Location of Broken Insulators and Other Transmission Line Troubles. L. C. Nicholson. Introductory to a discussion. Explains a method of locating faults consisting of supplying current from a generator and transformer to the fault to earth through a divided circuit or a loop, formed by joining two line conductors together at both ends, one of the wires so connected containing the broken insulator to be located. Ills. 2700 w. Pro Am Inst of Elec Engrs—May, 1907. No. 85281 D.

Single Phase.

One-Phase High-Tension Power Transmission. E. J. Young. Proposes a high-tension one-phase system having several desirable features not in common with either the direct-current or the three-phase system. 1500 w. Pro Am Inst of Elec Engrs—May, 1907. No. 85282 D.

Spans.

Transmission Line Towers and Economical Spans. D. R. Scholes. Introductory to a general discussion. De-

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scribes a method by which the relation between the height, strength, and cost of a tower of given form may be expressed and its application to the problem of fixing the economical span for any given transmission line. 3300 w. Pro Am Inst of Elec Engrs—May, 1907. No. 85279 D.

Wireless Energy.

The Operation of Mechanical Devices at a Distance by Means of the Wireless Transmission of Energy. Dr. Alfred Gradenwitz. Gives a brief review of the principles of wireless telegraphy and their application for the purpose of producing mechanical effects. Ills. 1500 w. Sci Am Sup—June 8, 1907. No. 84823.

MISCELLANY.

Insulating Materials.

The Manufacture of Electrical Porcelain. Dean Harvey. Illustrates and describes the process of manufacture. 1200 w. Elec Jour—June, 1907. No. 85133.

Phono-Cinematograph.

The Phono-Cinematograph (La Phono-Cinématographie). A. Bidault des Chaumes. Illustrated detailed description of apparatus for reproducing at the same time sounds by a phonograph arrangement and scenes by a cinematograph. 5000 w. Génie Civil—May 11, 1907. No. 84908 D.

INDUSTRIAL ECONOMY

Apprenticeship.

A Rational Apprentice System. An illustrated detailed description of the apprentice system recently introduced on the New York Central lines and being extended throughout the system. 7500 w. Am Engr & R R Jour—June, 1907. No. 84783 C.

Real Apprenticeship. G. M. Basford. Considers briefly some of the fundamental principles likely to lead to success. 1000 w. Am Engr & R R Jour—June, 1907. No. 84789 C.

Board of Trade.

British Board of Trade. A. R. Bell. An explanation of the powers and functions of this important organization. 2500 w. Ry & Loc Engng—June, 1907. No. 84773 C.

Contract Work.

The Responsibility of the Engineering Profession for the Conduct of Public Contracts. Major Cassius E. Gillette. Considers the processes of letting public contracts, and the duty of all honest engineers to follow such methods as will make fraud exceedingly difficult. 5000 w. Eng News—May 30, 1907. No. 84695.

Cost Keeping.

Expense: Man-Hour Distribution. F. E. Webner. The tenth of a series of articles on cost keeping. 1500 w. Ir Trd Rev—June 13, 1907. No. 85030.

Cost Accounts. H. F. J. Porter. Discusses the function of a cost accounting system and matters relating to such systems. 1800 w. Am Mach—Vol. 30, No. 26. No. 85297.

Machine-Shop Cost Estimating. George Bilham. Gives an analysis of the various factors, showing that there is too much addition for slide-rule computation. 1800 w. Am Mach—Vol. 30, No. 22. No. 84683.

Delivery.

How to Keep Promises of Delivery. J. Stratton. Gives details of a system adopted and found successful for insuring the fulfilment of promises of quick delivery of shop work. 1500 w. Elec Rev, Lond—June 14, 1907. No. 85238 A.

Education.

Lantern Slides for Shop Instruction. Charles A. Francis. Illustrated description of a method devised to teach Japanese workmen. Gives a set of slides showing mistakes made by workmen. 700 w. Am Mach—Vol. 30, No. 25. No. 85150.

Technical Training of Electrical Artisans. C. P. C. Cummins. Abstract of a paper before the Dublin Sec. of the Inst. of Elec. Engrs. Considers existing methods of training and the results, and a proposed system. Discussion. 3300 w. Elect'n, Lond—May 24, 1907. No. 84755 A.

The Technical Teaching of Electricity in France and in Foreign Countries (L'Enseignement Technique de l'Electricité en France et à l'Etranger). G. de Lamarcodie. Discusses equipment and teaching methods in a large number of European technical schools with especial reference to the more important French institutions. Ills. 8500 w. Revue Gen des Sci—May 30, 1907. No. 84905 D.

Some Recent Additions to the Technical Equipment of the Chemical Engineering Laboratories. Judson C. Dickerman. Describes machines recently added for work in industrial chemistry, and for technical gas analysis at the University of Wisconsin. Ills. 1000 w. Wis Engr—June, 1907. No. 85130 D.

Eight-Hour Day.

Report of the Miners' Eight Hour Day Inquiry Committee. Gives most of the important parts of this lengthy document which contains valuable informa-

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tion in regard to the economic conditions of the working of coal mines. Also editorial. 25000 w. Ir & Coal Trds Rev—May 24, 1907. Serial. 1st part. No. 84766 A.

Miners' Eight-Hour Day. Editorial discussion of the final opinion of the Committee appointed to inquire into the probable economic effect of a limit of eight-hours to the working-day of coal miners. 3000 w. Engng—May 31, 1907. No. 84894 A.

Engineering Building.

United Engineering Society Building. Description by the historical and publication press committee prepared for the dedication exercises of this building in New York City. Ills. 7000 w. Bul Am Inst of Min Engrs—May, 1907. No. 85268 C.

Engineering Ethics.

Proposed Code of Ethics. Gives the committee report of the Am. Inst. of Elec. Engrs. presenting a code of general principles of professional conduct for the guidance of the electrical engineer. 2000 w. Pro Am Inst of Elec Engrs—May, 1907. No. 85286 D.

Address by Arthur T. Hadley at the Dedication of the United Engineering Society Building in New York City. On what may be accomplished by engineers—his professional obligations. 2500 w. Bul Am Inst of Min Engrs—May, 1907. No. 85269.

Exhibition.

The Tokyo Industrial Exhibition. Charles A. Francis. An illustrated article outlining the purpose of the exhibition, the industries to be represented, and showing what has been done in a few months. 1200 w. Am Mach—Vol. 30, No. 24. No. 85010.

Financial Outlook.

Business and Finance in 1907; Retrospect and Prospect. Editorial discussion of the present condition in the security market, and the causes that can be looked for to change it. 2200 w. Eng News—June 27, 1907. No. 85302.

Foundry Management.

A System of Management in a Foundry. A brief account of the experience of a steel foundry with the task and bonus system. 1200 w. Ir Trd Rev—June 13, 1907. No. 85031.

Immigration.

The Italian on the Land: A Study in Immigration. Emily Fogg Meade. An account of the Italian population of Hammonton, N. J., showing how well they are adapted for agricultural pursuits, and giving much information in regard to their progress, industry, etc. 27000 w. Bul Bureau of Labor—May, 1907. No. 85262 N.

Labor.

The Labor Movement. Robert Gunn Davis. A psychological study, reviewing briefly the evolution and the social tendencies of trades unionism. Principally confined to conditions in England. 4500 w. Westminster Rev—June, 1907. No. 85259 D.

Labor Efficiency.

The Efficiency of the Worker and His Rate of Pay. Clive Hastings. Presents the advantages and disadvantages of the day rate, piece work and the bonus systems, with suggestions for determining a just wage. 3000 w. Am Engr & R R Jour—June, 1907. No. 84791 C.

The Methods of Exact Measurement Applied to Individual and Shop Efficiency at the Topeka Shops of the Santa Fe. Harrington Emerson. Describes the results accomplished at these shops, and the methods used. 3300 w. Am Engr & R R Jour—June, 1907. No. 84788 C.

Roundhouse Betterment Work. J. F. Whiteford. A description of a system of rewarding individual ability through increased pay as solved on the Santa Fe. 2200 w. Am Engr & R R Jour—June, 1907. No. 84786 C.

Labor Legislation.

A Short History of Labor Legislation in Great Britain. A. Maurice Low. Discusses principally factory conditions and legislation. 21500 w. Bul Bureau of Labor—May, 1907. No. 85263 N.

British Workmen's Compensation Acts. Launcelot Packer. A review of British legislation in regard to the compensation of workmen for injuries received in their employment, with full text of the Act of 1906, to take effect July 1, 1907. 29000 w. Bul Bureau of Labor—May, 1907. No. 85264 N.

Management.

Profit-Making in Shop and Factory Management. C. U. Carpenter. This sixth of a series of articles deals with methods for fixing standard times for manufacturing operations. 4500 w. Engineering Magazine—July, 1907. No. 85308 B.

Motive Power.

Statistics and Economic Importance of the Motive Power Problem (Statistique et Importance Economique de la Force Motrice Technique). C. Ballod. Discusses the importance of the motive power problem in relation to agriculture and industry and the status of gas motors, wind, water and sun power, with statistical information. 10000 w. Rev Econ Inter—May, 1907. No. 84912 H.

National Policy.

President Roosevelt Outlines His Railway Policy. Extracts from a speech delivered at Indianapolis outlining the na-

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tional policy in reference to railways. Also editorial. 3000 w. Ry Age—June 7, 1907. No. 84830.

Open Shop.

The True Meaning of the Open Shop. James W. Van Cleave. An authoritative statement of the aims of the proposed educational campaign of the National Assn. of Manufacturers and the purpose in forming the federation and raising the fund for the work. 3000 w. Engineering Magazine—July, 1907. No. 85304 B.

Pacific Coast.

The Pacific Coast: An Inspiration to America. Albert Phenis. A review of the development and the causes of its prosperity. 5000 w. Mfrs Rec—June 27, 1907. Serial. 1st part. No. 85287.

Philippine Islands.

Engineering Works and Surveys in the Philippine Islands. G. R. Putnam. An outline of the progress in engmeering works and surveys since the American occupation, describing the features of the islands of interest to engineers. 5000 w. Eng News—June 20, 1907. No. 85160.

Public Utilities.

The Public Utilities Law of New York. Editorial discussion of this law for the control of corporations which takes effect July 1st, 1907. 1700 w. Eng News—June 13, 1907. No. 85028.

The Public Utilities Bill. Full copy of the bill recently passed by the New York legislature, providing for regulation of railroads and public service companies. Also editorial. 20000 w. R R Gaz—May 31, 1907. No. 84670.

Securities.

Street Railway Securities—A Symposium. Contributions by Max Teichmann, Carl H. Nau, R. S. Buchanan, and editorial introduction by W. H. Lough, Jr. 3800 w. Jour of Acct—June, 1907. No. 85125 C.

Street Railway Bonds as Investments. Herbert G. Stockwell. A comparison with steam railroad bonds. 4500 w. Jour of Acct—June, 1907. No. 85126 C.

Stock Keeping.

A Stock Keeping System. Howard Hunt. Describes the system employed by the Cincinnati Planer Co. for ordinary stock supplies and keeping track of and distributing to the shop. 800 w. Ir Age—June 20, 1907. No. 85140.

U. S. Customs.

The United States Customs Service. Charles Leo Frank. Considers the organization and administration of that portion of the Customs Service which is directly concerned with the collection of duties on articles imported. 2200 w. Jour of Acct—June, 1907. No. 85127 C.

MARINE AND NAVAL ENGINEERING

Condensers.

Notes on Vacuum in Connection with Marine Machinery. H. C. Dinger. Discusses various matters that affect the vacuum, and how to get the most out of the condensing apparatus. 1500 w. Int Marine Engng—June, 1907. No. 84659 C.

Cruiser.

Launch of the New Scout Cruiser Birmingham. Illustrates and describes a new type of vessel for the U. S. Navy. 1500 w. Naut Gaz—June 6, 1907. No. 84835.

Derelict Destroyer.

New United States Derelict Destroyer. Illustrated description of the plans for the first derelict destroyer, Revenue Cutter No. 17, for which bids have been solicited. 1000 w. Marine Rev—June 6, 1907. No. 84825.

Destroyers.

The Ocean Race of Torpedo-Boat Destroyers. Brief account of the race over the 240-mile course from Sandy Hook to Cape Charles. Ills. 1000 w. Sci Am—June 15, 1907. No. 85014.

Dredge.

The Dredge "Independent." Illustrated detailed description of the 4½-yd. dipper dredge used constantly since 1906, in the extension of South Brooklyn docks. 1400 w. Eng Rec—June 1, 1907. No. 84700.

Dry Docks.

Floating Dry Dock No. IV at Rotterdam (Das Rotterdamer Schwimmdock IV). An illustrated detailed description of construction and operation. 2000 w. Elektrotech u Polytech Rundschau—May 1, 1907. No. 84950 D.

Gyrostat.

Practical Tests of the Schlick Gyrostat for Ships. Illustrated description of this apparatus for diminishing the rolling of ships, and of tests made. 1700 w. Sci Am—June 15, 1907. No. 85015.

Hydroplanes.

A Twelve-Foot Gliding Boat. Alfred E. Luders. Illustrates and describes a small hydroplane that may be built by an amateur. 3500 w. Rudder—June, 1907. No. 84731 C.

How to Build a Hydroplane Gliding Boat. William and Walter Stearns. Drawings and full directions. 1000 w. Sci Am Sup—June 15, 1907. No. 85016.

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Inland Navigation.

Improvements Required in Inland Navigation. Henry Rodolph de Salis. Read before the Inst. of Min. Engrs. A discussion of the inland waterways of England and Wales. 3000 w. Ir & Coal Trds Rev—June 14, 1907. No. 85256 A.

Labrador Boats.

Eskimo and Indian Boats of Labrador. Stephen P. M. Tasker. Brief description of types of boats used along the coasts of Labrador, which differ but slightly from those used hundreds of years ago. 900 w. Int Marine Engng—June, 1907. No. 84660 C.

Magnetic Material.

On Some Experiments on the Magnetic Character of Vessels. Capt. W. Bartling. Read before the N. E. Coast Inst. of Engrs. and Shipbldrs. A report of observations made to obtain actual quantitative measurements of the effect of various influences on the standard compass. 1400 w. Elec Engr, Lond—May 31, 1907. No. 84880 A.

The Effect of Current Sheets on the Compass Needle on Board Iron Ships. C. Arldt. Trans. from *Elektrotechnische Zeitschrift*. A theoretical and experimental investigation. 1000 w. Elec Rev, Lond—May 31, 1907. No. 84881 A.

Propulsion.

The Del Proposto System of Electrical Transmission Gear for the Propulsion of Ships by Irreversible Engines. Describes an electrical method of power transmission in connection with the use of irreversible internal combustion engines for the propulsion of ships. 900 w. Sci Am Sup—June 22, 1907. No. 85164.

A New Method of Ship Propulsion (Een Nieuwe Wijze van Voortbeweging voor Stoomschepen). A. G. Bosman. Illustrates and describes a method of steamship propulsion by means of an endless chain of traveling buckets. 3000 w. De Ingenieur—May 18, 1907. No. 84991 D.

Signaling.

Submarine Signaling (Segnalazioni Sottomarine). Luigi Boggiano. A comprehensive review of the methods used and the results obtained from trials in various navies. Ills. 10000 w. Rivista Marittima—No. 84917 E + F.

Steamers.

The New Steamers Mexican and Columbian. Illustrates and describes two freighters, being built at San Francisco, and their equipment. 2500 w. Int Marine Engng—June, 1907. No. 84657 C.

The Pacific Twin-Screw Steamers "Quillota" and "Quilpue." Illustrated description of steamers intended for passenger and mail service on the west coast of South America. 1200 w. Engng—June 14, 1907. No. 85244 A.

Tank Steamer.

A Large Oil Steamer. Plans and description of the largest tank steamer ever built in the United States. The cargo oil capacity is 2,500,000 gallons. 3800 w. Int Marine Engng—June, 1907. No. 84661 C.

Torpedo Boats.

Notes on Motor Torpedo Launches. C. T. Brady, Jr. Discusses the advantages of the internal combustion engine for this service. Ills. 700 w. Int Marine Engng—June, 1907. No. 84658 C.

Oil-Fuel Turbine-Driven Torpedo-Boats. Illustrated descriptions of a new series of boats for the British Navy. 1500 w. Engng—May 24, 1907. No. 84757 A.

Turbines.

The Turbine Mail Steamer "Princesse Elisabeth" (La Malle-Poste à Turbines "Princesse Elisabeth"). E. and H. Comhaire. Describes the machinery and gives the results of tests of this steamer built for service between Dover and Ostende. Ills. 2500 w. Bull Sci d l'Assn des Elèves—April, 1907. No. 84904 D.

MECHANICAL ENGINEERING

AUTOMOBILES.

Bollee.

The 1907 Leon Bollée Cars. Illustrates one of the 4-cylinder live-axle models, and describes this car mainly, though referring to other types. 2000 w. Auto Jour—May 25, 1907. No. 84742 A.

Carburetter.

The Craven Carburetter. Illustrated description, with report of seven tests made. 1300 w. Autocar—June 15, 1907. No. 85233 A.

Car Fittings.

An Interesting Car and Its Refinements. Brief illustrated description of the equipment of Mr. Henry Edmund's Daimler. 1200 w. Auto Jour—May 25, 1907. No. 84743 A.

Commercial Vehicles.

The Stoltz Steam Tractor (Dampf-Lastwagen Bauart Stoltz). Herr Pflug. Illustrates and describes the boiler, engine, and construction details of this vehicle for heavy freight service. 3500 w.

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Zeitschr d Mit Motorwagen Ver—May 15, 1907. No. 84948 D.

Patrol Lorry. Illustrated description of a motor wagon or lorry, for heavy hauling, made in Milwaukee, in which both axles are driven. 900 w. Engr, Lond—June 14, 1907. No. 85248 A.

Early Vehicles.

A Relic of Early Motor Vehicles. Frank C. Hudson. Illustration, with brief account of a self-propelled vehicle which made regular trips in 1834 in Scotland. 400 w. Am Mach—Vol. 30, No. 26. No. 85296.

Expositions.

The International Automobile Exposition in Berlin in the Autumn of 1906 (Die Internationale Automobilausstellung in Berlin, Herbst 1906). A. Heller. Illustrated detailed descriptions of the exhibits, the first part dealing with internal-combustion-motor cars. 4000 w. Serial. 1st part. Zeitschr d Ver Deutscher Ing—May 18, 1907. No. 84982 D.

The First International Exposition of Commercial Automobiles in London, March, 1907 (Die erste Internationale Motorlastwagen-Ausstellung in London März 1907). Herbert Bauer. Illustrated detailed description of a large number of cars shown. 7000 w. Zeitschr d Mil Motorwagen Ver—April 30, 1907. No. 84946 D.

Ford.

The Ford Petrol Cars. Illustrates and describes these American-built cars, especially a 4-cylinder model. 700 w. Auto Jour—June 1, 1907. Serial. 1st part. No. 84875 A.

Gears.

The Chenard-Walcker Speed Gear. Illustrated description. 700 w. Autocar—June 15, 1907. No. 85234 A.

Martini.

The 40-50 H. P. Martini Car. Illustrated description. 1200 w. Autocar—June 1, 1907. No. 84874 A.

Motor Cooling.

The Anatomy and Pathology of Friction-Driven Pumps. Charles T. W. Hirsch. On this means of effecting water circulation for the prevention of overheating in automobiles and the difficulties. 1100 w. Motor Car Jour—June 15, 1907. No. 85231 A.

Motors.

Points of Resemblance and Difference in Our Automobile Motors (Aehnlichkeiten und Verschiedenheiten unserer Automobilemotoren). Ludwig von Löw. Compares several of the leading European types with regard to transmission, ignition, etc. Ills. 7000 w. Zeitschr d Mit Motorwagen Ver—May 15, 1907. No. 84947 D.

Omnibuses.

Petrol Motor Omnibuses. C. C. B. Morris. Abstract. Considers points in connection with the management and design of motor omnibuses. 2800 w. Prac Engr—May 31, 1907. No. 84878 A.

Omnibus Service.

The Present Cost of Motor Bus Services. Mr. Vellguth. Gives detailed information of results obtained by German and English companies. 12700 w. Bul Int Ry Cong—May, 1907. No. 85290 E.

Racing Track.

Brooklands Motor Track. A remarkable motor track nearing completion in England is illustrated and described. 2500 w. Auto Jour—June 1, 1907. No. 84876 A.

Spark Inductors

Theory and Design of Spark Inductors (Theorie und Vorausberechnung der Funkeninduktoren). E. W. Ehnert. The first part of the serial is devoted to a theoretical discussion of induction. Ills. Serial. 1st part. 3500 w. Elektrotech u Maschinenbau—May 5, 1907. No. 84975 D.

Speed Indicators.

Smith's Speed-Indicator Factory, Watford. Illustrates and describes these speed-indicators for motor-cars, and the factory where they are made. 1200 w. Engng—May 31, 1907. No. 84893 A.

Troubles.

General Pointers for the Novice Owner. Charles B. Hayward. Advice to beginners in driving automobiles, calling attention to troubles that are perplexing. 2500 w. Automobile—June 20, 1907. No. 85213.

COMBUSTION MOTORS.

Alcohol.

Alcohol for Power. John A. Secor. Reviews the present status of alcohol as a fuel for internal combustion engines. 4000 w. Mach, N Y—June, 1907. No. 84687 C.

Cylinders.

Stresses due to Heat in Hollow Cylinders (Temperaturspannungen in Hohlzylindern). Rudolph Lorenz. A mathematical discussion of the stresses in gas-engine cylinders due to unequal heating outside and inside. Diagrams. 4000 w. Zeitschr d Ver Deutscher Ing—May 11, 1907. No. 84981 D.

Diagrams.

Recreative Reading of Diagrams. L. Baudry de Saunier. Especially interprets the diagrams of automobile gas engines. 1500 w. Automobile—June 13, 1907. No. 85033.

Gas Engineering.

Gas Engineering. W. A. Baehr. Shows that a gas engineer needs to have civil, mechanical, electrical, and chemical knowl-

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edge. Considers the manufacture of artificial gases and their distribution. 8800 w. Jour Assn of Engng Socs—May, 1907. No. 85141 C.

Gas Engines.

History of the Progress of the Gas Engine. E. J. Williams. Reviews interesting inventions in this field since 1678, showing the development. 2500 w. Rudder—June, 1907. No. 84732 C.

A Historical Review of Gas-Engine Construction (Geschichtlicher Rückblick im Gasmotorenbau). A sketch of the development of the gas engine during the past fifty years. 2000 w. Elektrotech u Polytech Rundschau—May 22, 1907. No. 84952 D.

Gas-Engine Efficiencies. Leonard Bairstow. Considers methods of making the calculations, giving tables. 1400 w. Engng—June 7, 1907. No. 85111 A.

Working Experiences with Large Gas Engines. Cecil A. St. George Moore. Shows some of the defects which have presented themselves in actual work, and by what means and to what extent they have been overcome. 6500 w. Soc of Engrs—June 3, 1907. No. 85120 N.

How to Build a 5-Horse-Power Stationary Gas Engine. E. F. Lake. Drawings and directions. 3000 w. Sci Am Sup—June 15, 1907. Serial. 1st part. No. 85018.

600 B.H.P. Horizontal Twin Cylinder Gas Engine. Illustrates and describes a gas engine constructed for driving a ring spinning mill. 2200 w. Mech Engr—June 15, 1907. No. 85236 A.

1200-Horse-Power Gas Engine. Illustrated detailed description of a large engine running in the power house at Bargold, near Cardiff, which is driving an alternator in parallel with other engines. 600 w. Engr, Lond—May 24, 1907. No. 84762 A.

Gas Producers.

General Principles in the Construction of Modern Gas Producers. R. E. Mathot. Discusses the elements of producer design, considering, particularly, producers operated with anthracite, semi-anthracite, or coke. Ills. 5000 w. Engineering Magazine—July, 1907. No. 85306 B.

Recent Progress in Producer Gas Power Installations. Godfrey M. S. Tait. Illustrates and describes a producer gas installation in which variation in the gas is avoided so far as possible. 2000 w. Sci Am Sup—June 22, 1907. No. 85163.

Suction Producer Gas, Its Formation and Economy as a Means for Generating Power in the Modern Producer Gas Engine. J. H. Clapperton. Briefly considers the comparative efficiency of the steam and gas engine, giving a detailed account of what takes place in a gas producer. Ills. 3000 w. Cent Sta—June, 1907. No. 84712.

Producer Gas for Power. James A. Charter. Illustrated description of a suction gas producer and its operation, with general remarks. 2000 w. Ir Age—June 27, 1907. No. 85295.

Gas Producer for Pulverized Fuel (Gazogène à Combustible Pulvérisé). An illustrated description of the Marconnet producer which is charged continuously with pulverized fuel and which is said to utilize anthracite or bituminous coal, or even bituminous shale with equal facility. 1600 w. Génie Civil— May 11, 1907. No. 84909 D.

Gas Producers (Ueber Gasgeneratoren). Johannes Körting. A thorough review of the subject, describing the construction and operation of many types of producers and giving tables of the results obtained from them. Ill. Diagrams. and Tables. 14000 w. Stahl u Eisen—May 15, 1907. No. 84939 D.

Ignition.

Electric Ignition in Gas and Gasoline Engines (Noté sur l'Allumage Electrique des Moteurs à Gaz et à Pétrole). H. Lhonoré. The first part of the serial deals with low-tension ignition, illustrating and describing numerous types of magneto. 1200 w. Serial. 1st part. Revue de Méchanique—May 31, 1907. No. 84994 E + F.

Liquid Fuels.

Vaporization of Liquid Fuels. Charles Edward Lucke. Types of carbureters and vaporizers for gasoline, kerosene, and alcohol are illustrated and described. 4000 w. Engr, U S A--June 15, 1907. No. 85091 C.

Oil Engine.

The Cross Patent Heavy Oil Engine. Illustrated description of an engine designed for use with petroleum. 1600 w. Autocar—June 8, 1907. No. 85094 A.

HEATING AND COOLING.

Central Plants.

Warming and Ventilating the New Convocation Hall, University of Toronto. Charles L. Hubbard. A group of four buildings in course of construction to be warmed and lighted by a central plant. The system is illustrated and described. 2000 w. Eng Rec—June 15, 1907. No. 85062.

Hot-Water Heating of a Large Group of Buildings (Mitteilungen über die Beheizung einiger Grösserer Gebäudegruppen with Warmwasser). A. C. Karsten. Illustrates and describes the heating systems of several groups of public buildings in Copenhagen. 2500 w. Gesundheits-Ing—May 25, 1907. No. 84971 D.

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Combination Plants.

Heating and Ventilating. F. M. Griswold. Describes the fire hazard of combination systems, giving suggestions, and noting dangerous practices. 1800 w. Ins Engng—June, 1907. No. 85194 C.

Furnace.

Furnace Heating in an Allegheny Church. An interesting example of hot-air heating by the use of two furnaces in one battery, one furnace being equipped for burning coal, and the other for both coal or natural gas. 2000 w. Met Work—June 15, 1907. No. 85038.

Hot Water.

The Heating of Water with Gas Fuel (Warmwasserversorgung mit Gasfeuerung). Paul Fusbahn. Illustrates and describes, in the first part of the serial, small bath-room installations for heating water as needed. Serial. 1st part. 4000 w. Gesundheits-Ing—May 11, 1907. No. 84968 D.

Office Building.

Heating and Ventilating the Title Guarantee Trust Building, New York. Plans and description of the systems installed. Ventilation is accomplished by both fresh air supply and exhaust. The heating is by direct radiation, utilizing exhaust steam. 4000 w. Eng Rec—June 1, 1907. No. 84702.

Refrigeration.

Mechanical Production of Low Temperatures. Sydney F. Walker. Discusses principles of refrigerating processes which may be used for cooling deep workings and in sinking by freezing. 4000 w. Eng & Min Jour—June 22. 1907. No. 85219.

Compression and Absorption Systems. Oswald Gueth. Gives considerations affecting the economy of the two systems and results from actual tests. 3300 w. Engr, U S A—June 15, 1907. No. 85089 C.

Combination Ice and Light Plants. Rufus E. Lee. Considers the cost of manufacturing ice in independent and combination plants. 3000 w. Ice & Refrig—June, 1907. No. 84728 C.

Steam Heating.

Comparative Cost of Steam Heating for Various Steam Pressure and Room Temperatures. John J. Harman. Gives information collected by the writer as to the amount of steam required in direct radiators for various steam pressures and room temperatures. 2000 w. Met Work—June 15, 1907. No. 85039.

Textile Mills.

A New Departure in Cooling and Humidifying Textile Mills. W. H. Carrier. Read before the Am. Assn. of Cotton Mfrs. Shows the Scientific principles applying to the artificial attainment of the conditions necessary in cotton mills, describing a system believed by the writer to embody such principles most effectually. 3300 w. Heat & Vent Mag—June, 1907. Serial. 1st part. No. 85266.

Theatre.

Construction and Operation of the Heating and Ventilating Arrangements of the New Theatre in Nürnberg (Bau und Betrieb der Heiz- und Lüftungseinrichtungen des Neuen Theatres in Nürnberg). O. Krell. An illustrated, detailed description. Serial. 2 parts. 22500 w. Gesundheits-Ing—May 18 and 25, 1907. No. 84970 D.

HYDRAULICS.

Canals.

The Effect of Changes in Canal Cross Sections Upon the Rate of Flow. F. W. Hanna. Gives briefly methods of determining mathematically the loss of head in canal flow due to contractions and expansions of cross section of waterway, either modified or unmodified. 2000 w. Eng News—June 6, 1907. No. 84820.

Centrifugal Pumps.

Various Types of Centrifugal Pumps and the Results of Tests (Verschillende Uitvoeringen en Beproevingsresultaten van Centrifugaalpompen met Vertikale Asopstelling). Chr. Feuwens. Gives tables of results of tests. Ills. 6000 w. De Ingenieur—May 18, 1907. No. 84990 D.

Recent Development and Future Application of Centrifugal Pumps. D. S. Brown. A comparison of centrifugal and reciprocating pump installations. 1800 w. Engr, U S A—June 15, 1907. No. 85090 C.

Kutter Formula.

Observations to Determine the Value of "C" and "N" as Used in the Kutter Formula. J. B. Lippincott. Describes methods of lining irrigating canals in California, and gives experiments made to study the working conditions of old lined canals to be used in connection with the designing of an aqueduct for the new water supply of Los Angeles. Ills. 2500 w. Eng News—June 6, 1907. No. 84815.

Piping.

A Study in Piping. William J. Splan. Gives detailed sketches and description of wrought-pipe drainage in the thirteen-story "DuPont" office building in Wilmington, Del. 1700 w. Dom Engng—June 15, 1907. No. 85067.

Pumping Engines.

High-Duty and Low-Duty Pumping Engines. From a paper by Irving H. Reynolds, before the Am. Water-Works Assn., regarding the points to be considered in making a choice between high-duty and low-duty types. 2500 w. Eng Rec—June 22, 1907. No. 85197.

Stream Flow.

Flood Flow in River Beds (Ueber das

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Fortschreiten von Hochwasseranschwellungen in Fluszläufen). Philipp Forchheimer. Mathematical paper. Ills. 5500 w. Zeitschr d Oest Ing u Arch Ver—May 3, 1907. No. 84972 D.

MACHINE WORKS AND FOUNDRIES.

Bearings.

Spherical Bearings with Few Tools. M. R. Lathrop. An illustrated explanation of how a lathe and boring mill were rigged up to handle a difficult job and the good results that were obtained. 900 w. Am Mach—Vol. 30, No. 23. No. 84799.

Bells.

Bell Mixtures. On the manufacture of cast bells, the principal mixtures, methods, etc. Ills. 1200 w. Brass Wld—June, 1907. No. 85168.

Boiler Making.

Concerning Nipples in Sectional Boilers. Calls attention to the failure of nipples due to their not being adequately set and flared. Ills. 2500 w. Locomotive—April, 1907. No. 85257.

The Areas of Circular Segments. Gives approximate rules which give accurate enough results for general use, when the tables for computing such areas are not at hand. 3300 w. Locomotive—April, 1907. No. 85258.

Boring.

Boring Bars and Cutters. E. A. Dixie. Describes the methods used by the Link-Belt Company. Ills. 1400 w. Am Mach—Vol. 30, No. 25. No. 85151.

Brass Foundries.

Healthful Conditions in the Brass Foundry. Walter B. Snow. Read before the Am. Found. Assn. Describes installations for the removal of dust and fumes. 2000 w. Eng Rec—June 15, 1907. No. 85061.

Science Applied to the Brass Industry. Andrew M. Fairlie. Read before the Am. Found. Assn. Discusses the work of the chemist and metallurgist, the problems of electroplating and other work. 2200 w. Ir Age—June 13, 1907. No. 85005.

Brass Skimmings. Explains what skimmings are, the right method of treating them, assays, etc. 1500 w. Brass Wld—June, 1907. No. 85170.

Case-Hardening.

The Case-Hardening Furnace. J. F. Sallows. Considers its use for hardening, coloring and mottling. Ills. 1500 w. Mach, N Y—June, 1907. No. 84689 C.

Castings.

The Manufacture of Sandless Castings. John H. Shaw. Read before the Am. Found. Assn. Describes sandless molds and the method of operating, stating the uses to which they are best adapted. Ills. 900 w. Ir Age—May 30, 1907. No. 84667.

Compressed Air.

The Development of Compressed Air Tools (Die Entwicklung des Pressluftwerkzeugbaues). Alexander Lang. Illustrates and describes various types of compressed air hammers, drills, riveters, etc., built by the Porkorny and Wittekind Company of Frankfort. Serial. 1st part. 2500 w. Schiffbau—May 22, 1907. No. 84943 D.

Dies.

Novel Ideas in Die Making. Illustrates and describes practices of the Providence Mfg. & Tool Co. 4000 w. Mach, N Y—June, 1907. No. 84690 C.

Drawing Presses.

Making Seamless Steel Bath-tubs by Toggle Press Method. Illustrates and describes the equipment of the Pressed Steel Sanitary Co., Detroit. 1500 w. Met Work—June 1, 1907. No. 84672.

Drilling Machine.

Horizontal Drilling and Tapping Machine. Illustrated description of a large machine recently designed and built for high-speed work. 600 w. Engng—May 24, 1907. No. 84758 A.

Fire-Gilding.

Mercurial or Fire-Gilding and Its Production. Illustrated description of the first form of plating known. 2800 w. Brass Wld—June, 1907. No. 85169.

Forging Press.

Black Country Enterprise. J. Horton. Illustrates and describes the plant of Walter Somers & Co., Ltd., at Halesowen, Eng., which is adapted to the production of heavy work; especially describing a large forging press. 2000 w. Ir Trd Rev—June 13, 1907. No. 85029.

Gears.

A Comparison of the Efficiency of Two Trains of Spiral Gears. Gives in detail calculations for determining which is the better arrangement of two different sets of spiral gears for gas engines. Ills. 1600 w. Mach, N Y—June, 1907. No. 84691 C.

Gear Teeth.

A Standard for Short Involute Gear Teeth. Charles H. Logue. Considers the defects of the present system and presents a proposed system. 1800 w. Am Mach—Vol. 30, No. 23. No. 84796.

Hammers.

A Driving Mechanism for Percussion Machines. M. Ed. Sauvage. Trans. from *Bul. of Soc. d'Encour. pour l'Ind. Nat.* Illustrated description of a French invention in which a crank-driven hammer is free at the instant of striking. 1400 w. Am Mach—Vol. 30, No. 23. No. 84798.

Lathe.

The New Pratt & Whitney Turret Lathe. Illustrated description of an open turret lathe, designed for handling both bar stock and castings and performing a

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variety of work. 4500 w. Ir Age—June 27, 1907. No. 85292.

Machine Tools.

Recent French Machine Tools (Neuere Französische Arbeitsmaschinen). Illustrates and describes lathes, shears, planers, etc. Serial. 3 parts. 3000 w. Zeitschr f Werkzeugmasch u Werkzeuge—May 5, 15, and 25. No. 84967 each D.

Milling Machines.

Milling Machine Output. P. V. Vernon. Considers the conditions to be observed if the best output is to be obtained from any reasonably well designed machine. Ills. 3000 w. Engr, Lond—May 31, 1907. No. 84896 A.

The Brown & Sharpe No. 4-B Milling Machine. Illustrated description of a tool designed especially for the heavier class of milling in machine, engine, and railroad shops. 1700 w. Ir Age—May 30, 1907. No. 84666.

Molding.

The Universal System of Machine Molding. E. Ronceray. Illustrates and describes the standard Universal machines and their operation, devised with a view to making pattern plates and stripping plates in the foundry, without the help of the machine shop. 2800 w. Ir Age—June 6, 1907. No. 84733.

An Interesting Foundry Problem. L. N. Perrault. The method of molding an acid egg or still is illustrated and described. 2200 w. Ir Age—June 13, 1907. No. 85002.

Ordnance.

The Coventry Ordnance Works, Limited. An illustrated description of the various establishments of this great undertaking. 3000 w. Engr, Lond—May 31, 1907. Serial. 1st part. No. 85000 A.

Planing.

A Regenerative Reverse Planing Machine. Illustrated description of a new planer designed on the principle of balancing the forces by recoil springs. 800 w. Engr, Lond—June 7, 1907. No. 85119 A.

Protecting Device.

Planer-way Protecting Device. Illustrates and describes an efficient arrangement used at the works of the Bullard Machine Tool Co., Bridgeport, Conn., for preventing core sand, chips, etc., from getting in the ways. 500 w. Am Mach—Vol. 30, No. 26. No. 85298.

Riddle.

A Loose Ring Riddle. E. H. Mumford. Illustrates and describes the Mumford loose ring power driven foundry riddle, giving results of working tests. 800 w. Ir Age—June 13, 1907. No. 85003.

Riveting.

How to Heat and Drive Steel Rivets. James Crombie. 1st prize paper. Explains in detail the essentials of good work. 2500 w. Boiler Maker—June, 1907. No. 85006.

How to Heat and Drive Steel Rivets. J. T. Goodwin. 2nd prize paper. Considers driving rivets on a "Bull" machine, pneumatic riveting, hand or snap riveting, etc. 1500 w. Boiler Maker—June, 1907. No. 85008.

Shop Equipment.

Equipment of a Concrete Machine Shop. L. A. Alford. Illustrates and describes the general equipment of the buildings devoted to manufacturing in the plant of the United Shoe Machinery Co., at Beverly, Mass. 3800 w. Am Mach—Vol. 30, No. 24. No. 85009.

Shop Extension.

Arrangement of a Pattern Shop in a Confined Space. Oscar E. Perrigo. States the requirements and shows how a very convenient small pattern shop was obtained. Ills. 1400 w. Ir Trd Rev—June 20, 1907. No. 85147.

The Russel Wheel & Foundry Co., Detroit. Illustrates and describes improvements including the rearrangement of old buildings and the building of a new foundry and structural steel shop. 1300 w. Ir Trd Rev—June 20, 1907. No. 85146.

Sizing.

Sizing Holes without Reamers. Frank E. Shailor. Explains how it is done. Ills. 500 w. Am Mach—Vol. 30, No. 22. No. 84681.

Spring Control.

Instrument Control Springs. Charles C. Garrard. Discusses the design of such springs, the theory of flat spiral springs being considered in the present article. 1600 w. Elec Engr, Lond—May 31, 1907. Serial. 1st part. No. 84879 A.

Spur Wheels.

Spur Wheels with Circular Teeth. A discussion of the approximation of the cycloidal and involute forms, with the minimum of reference to the primary form. 2500 w. Engr, Lond—May 31, 1907. No. 84898 A.

Taps.

Remarks on the Making of Hand Taps. Erik Oberg. Information and data intended to supplement a number of previous articles. 1700 w. Mach, N Y—June, 1907. Serial. 1st part. No. 84092 C.

Tempering.

Tempering Ovens (Ueber Härteöfen). Otto Goldschmidt. Illustrated description of various types, heated by coal, coke, gas, or electricity. 2500 w. Stahl u Eisen—May 29, 1907. No. 84941 D.

Toggle-Joints.

The Ratio of Effective Pressure with Toggle-Joints. W. H. Butz. Deals with

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maximum results obtained with machines embodying the toggle-joint when the joint is straightened out. 900 w. Mach, N Y—June, 1907. No. 84688 C.

Tools.

Tool Room Care and Economy. F. G. De Saussure. An explanation of a system, illustrating its application. Ills. 2000 w. Eng & Min Jour—June 15, 1907. No. 85049.

Standardization of Special Tools. M. E. Ellis. Illustrates and describes a few standard types of drilling jigs and standard small parts for jigs and fixtures, as screws, bushings, and straps. 1500 w. Am Mach—Vol. 30, No. 23. No. 84794.

Triangulation.

Triangulation. Explains the layout of a "Y" connection. 800 w. Boiler Maker —June, 1907. No. 85007.

Tubes.

Inshaw's System of Manufacture of Solid Wrought-iron Tubing. W. H. Booth. Explains the process, and gives reasons why wrought iron is better than steel. 1200 w. Am Mach—Vol. 30, No. 22. No. 84682.

Welding.

"Autogenous" Welding with the Oxygen-Acetylene Blowpipe. Outlines some of the interesting features of a plant in Worcester, Mass., where this process has been installed. Ills. 1500 w. Eng News —June 27, 1907. No. 85300.

Works.

A Large Engineering Works in Holland. J. B. Van Brussell. Illustrations and details of the new plant of the A. F. Smulders Shipbuilding and Engineering Works at Schiedam. 800 w. Am Mach —Vol. 30, No. 25. No. 85149.

The Wheeling Mold and Foundry Co. An illustrated description of a well-equipped plant for the manufacture of heavy machinery. 2500 w. Ir Trd Rev—May 30, 1907. No. 84675.

MATERIALS OF CONSTRUCTION.

Abrasives.

Modern Abrasive Materials and Their Use in Shop Practice. J. Royden Peirce. Discusses kinds of abrasives, and their behavior, the principles of abrasive wheels, their form, use, etc. 3300 w. Eng News—June 6, 1907. No. 84819.

Aluminium.

Progress in the Use of Aluminium in 1906. Joseph W. Richards. Shows how improved methods of working this metal have extended its use as a light durable material and as a dioxidizing agent. 3000 w. Eng & Min Jour—June 15, 1907. No. 85053.

Cast Iron.

Manganese in Cast Iron. Herbert E. Field. Read before the Am. Found. Assn. An explanation of the effects of manganese on cast iron, aiming to reconcile conflicting statements. 2000 w. Ir Trd Rev—June 6, 1907. No. 84735.

Earthenware.

Making Vitreous Sanitary Ware. Illustrates and describes the equipment and processes of the potter. 2500 w. Met Work—June 8, 1907. No. 84767.

Fire Brick.

The Use and Abuse of Fire Brick for Locomotive Fire-boxes. J. E. Bond. Considers general details applying to the manufacture of all fire brick, the care needed, abuse, etc. 1800 w. R R Gaz—June 7, 1907. No. 84812.

Fireproof Material.

Artificial Fireproof Stones. Information in regard to fireproof materials for electric furnaces, smelting furnaces, artificial dinas material, fireproof crucibles, etc. 3800 w. Sci Am Sup—June 8, 1907. No. 84824.

Malleable Iron.

Etching Malleable Iron for the Visual Investigation of Structure. Prof. E. Heyn. Abstract of a report presented to the International Assn. for Test. Mat., Brussels Congress. Describes some things that may be learned as to the structure of iron and steel by inspecting etched surfaces, especially with the unaided eye. Ill. 1500 w. Am Mach—Vol. 30, No. 23. No. 84797.

Pipe.

A New Lock-Bar Steel Pipe. Max Kronauer. States the objections to riveted pipe, and illustrates and describes a pipe in which the adjoining edges are inserted into grooves and clamped by compression. 1200 w. Eng News—June 13, 1907. No. 85027.

Steel.

Behavior of Carbon and Phosphorus in Steel. Henry M. Howe. A discussion of J. E. Stead's explanation of the banding of carbon and phosphorus and the theory of incompatibility. 3000 w. Eng & Min Jour—June 8, 1907. No. 84837.

Tube Sheets.

Tests of Very Mild Steel Tube Sheets. A report of tests recently made at the repair shops of the Prussian railroads, describing a new sheet the construction of which meets the requirements of the heaviest service. Ills. 1000 w. R R Gaz —June 7, 1907. No. 84810.

MEASUREMENT.

Composimeter.

The Uehling Gas Composimeter. Illustrated description of an instrument which shows the quality of the flue gas, which is an index of the completeness of combustion. 2000 w. Power—June, 1907. No. 84656 C.

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Computer.

A Time and Cost Computer for the Boring Mill. William Cox. Describes a circular slide rule in which the various scales have been given special values corresponding to the elements in the required calculation. 500 w. Am Mach—Vol. 30, No. 24. No. 85012.

Frames.

Punching- and Shearing-Machine Frame Calculations. Gives a method for calculating the stresses in such a frame. 900 w. Am Mach—Vol. 30, No. 23. No. 84795.

Gaging.

Gaging Systems and Gages. Joseph V. Woodworth. Calls attention to the design, construction, use, and application of measuring and testing instruments. 2000 w. Ir Trd Rev—June 13, 1907. No. 85032.

Gears.

Diagram for Finding the Strength of Bevel Gears. H. T. Millar. Gives diagram, illustrating its use by examples. 600 w. Am Mach—Vol. 30, No. 24. No. 85011.

Punching Machine.

Design of a Punching and Shearing Machine. Gives the main calculations that are necessary to get out a design. 1500 w. Prac Engr—May 24, 1907. Serial. 1st part. No. 84744 A.

Pyrometry.

Pyrometry in Modern Workshop Practice. Charles R. Darling. Discusses various types of industrial pyrometers, showing that no single pyrometer is suited to every operation, and that the instruments should be fitted for the purpose intended. Ills. 5000 w. Engr, Lond—June 14, 1907. No. 85246 A.

Sentinel Pyrometers. Discusses their application to the annealing, hardening and general treatment of tool steel. 2000 w. Ir Age—June 13, 1907. No. 85004.

Principle and Operation of the Féry Radiation Pyrometer. C. H. Wilson and Frederick Maeulen. Illustrates and describes this instrument for measuring all temperatures over 500° C. (932° F.) by merely sighting a telescope at the hot body and reading the results direct from a needle over a graduated scale of a millivoltmeter. 2000 w. Sch of Mines Qr—April, 1907. No. 85019 D.

Steam Flow.

Formulas for the Flow of Steam in Pipes. Prof. G. F. Gebhardt. A comparison of accepted formulas, with curves showing the drop in pressure for different pipe sizes and velocities. 2500 w. Power—June, 1907. No. 84655 C.

Torsion.

A New Torsion-Meter. B. Hopkinson and L. G. P. Thring. Describes an apparatus designed by the authors, reporting tests. Ills. 2700 w. Engng—June 14, 1907. No. 85242 A.

POWER AND TRANSMISSION.

Blast Furnace Gases.

The Utilization of Blast Furnace Gases for Power Production. Albert L. O. Genter. Shows how the problems of eliminating flue dust from blast furnace gases, and the construction of gas engines large enough to meet the demands of power for a steel plant, were solved. 2500 w. Min Rept—June 13, 1907. Serial. 1st part. No. 85082.

Compressed Air.

Standards of Efficiency in Compressed Air Practice—The Air Compressor as an Air Meter. Frank Richards. Considers the indicator card as a basis for computing efficiency, the influence of temperature, and the effect of air valves. 1800 w. Mach, N Y—June, 1907. No 84693 C.

The Proper Installation and Use of Compressed Air in Railway Shops and Manufacturing Establishments. W. P. Pressinger. Deals with pneumatic tools, their applications and related subjects. Discussion. 7500 w. Pro Cent Ry Club—May 10, 1907. No. 85043 C.

The Use of Coolers in Air Compression. Frank Richards. Points out the advantages, and discusses cost, the two-stage system, and other matters. 1200 w. Eng & Min Jour—June 1, 1907. No. 84707.

Cost.

Steam Power vs. Gas Power. D. L. Fagnan. Information relating to comparisons between costs of power from gas engines, and steam or electricity. 1000 w. Engr, U S A—June 1, 1907. No. 84781 C.

Use of Exhaust Heat and Comparative Cost of Installation. L. G. Findlay. An investigation of the cost of steam and gas plants, and matters related. 1500 w. Engr, U S A—June 1, 1907. No. 84782 C.

Cranes.

150-Ton Hammer Derricking-Crane. Illustrates and describes a crane erected at Birkenhead, which is a modification of the hammer-head type. Electricity is used as the motive power. Plate. 2000 w. Engng—June 7, 1907. No. 85113 A.

A Novel Lumbering Crane. Henry Hale. Illustrated description of the McGiffert loader, which can be utilized as a locomotive or stationary engine, for skidding logs and piling them for transportation. 1100 w. Sci Am Sup—June 15, 1907. No. 85017.

Electric Driving.

The Driving of Wood-Working Machines by Electricity. Presents the advantages of electric driving and gives in-

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formation in regard to its application. Ills. 4000 w. Engr, Lond—June 7, 1907. No. 85118 A.

Gas Power.

The Gas-power Situation in America. F. E. Junge. Gives a short résumé of the growth and extent of power application in the United States, and a discussion of the gas-power situation from the viewpoint of a foreign observer of American industrial conditions. 2200 w. Power—June, 1907. No. 84654 C.

Grab Buckets.

Recent Types of Grab Buckets for the Handling of Heavy Material (Types Récents de Bennes-Griffes pour la Manutention des Matières Pondéreuses). Illustrated description of several types especially adapted for loading and discharging ships. 2000 w. Génie Civil—May 25, 1907. No. 84911 D.

Power Plants.

Hydro-Electric Power versus Steam for Industrial Plants. H. von Schon. The fourth and last article of a series. Outlines the professional equipment needed by an engineer expected to report on a hydro-electric project, and the essential features of the examination on which to base conclusions. 5000 w. Engineering Magazine—July, 1907. No. 85311 B.

Power Plant Equipment of the Boston Store. Illustrates and describes the machinery for furnishing light, heat and power in the Charles Netcher building in Chicago, Ill. 2000 w. Engr, U S A—June 15, 1907. No. 85088 C.

The Power Plant of the Cleveland, O., Arcade. H. W. Woodward. Illustrates and describes modern ways of getting best efficiency in a plant where compactness was imposed by severe conditions. 3300 w. Engr, U S A—June 1, 1907. No. 84780 C.

STEAM ENGINEERING.

Boiler Explosions.

Boiler Explosions. Editorial discussion of causes. Maltreatment and ignorance, bad design, neglect, overheating, deterioration, etc., are considered. 4500 w. R R Gaz—June 7, 1907. No. 84800.

Boiler Waters.

How to Judge Boiler Waters from Analyses. John G. A. Rhodin. Outlines how to draw conclusions from simple water analysis, illustrating by actual examples. 3000 w. Engr, Lond—May 31, 1907. No. 84895 A.

Combustion.

Efficiency in the Burning of Fuel Under the Steam Boiler. William D. Ennis. This second article of a series discusses the regulation and control of furnace draft. Ills. 2000 w. Engineering Magazine—July, 1907. No. 85309 B.

Condensation.

Latest Development in Condensing Plants. S. Zylberlast. Reviews the development of condensing plants from the time of their first appearance in the year 1695 up to the present day. Ills. 4000 w. Prac Engr—June 14, 1907. Serial. 1st part. No. 85235 A.

Exhaust Steam.

Back Pressure in Exhaust Steam Heating. Charles L. Hubbard. Shows graphically the important features connected with the raising of the initial or boiler pressure, or increasing the cut-off of the engine to offset this loss. 700 w. Heat & Vent Mag—June, 1907. No. 85265.

Steam Power vs. Gas Power. F. W. Ballard. A comparison showing the advantages to the steam engine from using exhaust steam heating. 2800 w. Engr, U S A—June 15, 1907. No. 85092 C.

Germany.

Recent Aims and Achievements in German Heat-Motor Construction (Neuere Ziele und Erfolge des Deutschen Wärmekraftmaschinenbaues). H. Dubbel. The first part of the serial begins a description of recent developments in steam engines and turbines. Ills. 4000 w. Serial. 1st part. Zeitschr d Ver Deutscher Ing—May 18, 1907. No. 84983 D.

Governors.

Experience with a Putnam Engine. W. H. Wakeman. Gives an experience with an old-fashioned Putnam engine of value to engineers in charge of any kind of a slow-speed governor that responds slowly to changes in the load carried. Ills. 900 w. Power—June, 1907. No. 84652 C.

Governors for High-Speed Engines. A. Houlson. Describes methods of governing steam engines, and types of governors. Ills. 3500 w. Mech Engr—June 8, 1907. Serial. 1st part. No. 85096 A.

Speed Variations Due to Engine Governors (Variations Périodiques de Vitesse dues aux Régulateurs des Moteurs). P. Boucherot. Gives a mathematical discussion of the theory of governors and points out the discrepancies between their theoretical effect and the results obtained in practice. Ills. 9000 w. Revue de Mécanique—May 31, 1907. No. 84993 E + F.

Natural Draught.

Construction of Natural Draught Furnaces. Walter J. May. Discusses some of the essentials of good natural draught, and the uses to which it may be applied. 1800 w. Prac Engr—May 31, 1907. No. 84877 A.

Stokers.

Dust-Fuel Stokers and Auxiliary Plant. W. R. Harrison. Read before the Leeds Univ. Engng. Soc. Discusses the conditions for complete combustion, methods of firing dust fuel, especially with natural

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draught and fuel mechanically introduced independent of the air supply—the Schwartzkopff system. 3500 w. Ir & Coal Trds Rev—May 24, 1907. No. 84764 A.

Superheating.

Superheated Steam for Steam Turbines. J. A. Moyer. Discusses some of the important properties of superheated steam, giving results derived from experience. 2500 w. Harvard Engng Jour—June, 1907. No. 85192 D.

Thermal Currents.

The Interchange of Heat in Steam-Engine Cylinders. W. F. Cleveland. A study of the flow of thermal currents and of the theory of the interchange of heat between the working steam and the internal surfaces of the cylinder walls and pistons. 2500 w. Engineering Magazine—July, 1907. No. 85310 B.

Turbine Plant.

Steam Turbine Plant in the Black Hills. H. Boyd Brydon. Illustrated description of the Pluma Station of the Consolidated Power & Light Co. of South Dakota and its cooling spray system for condensing water. 2000 w. Engr, U S A —June 1, 1907. No. 84779 C.

Turbines.

Recent Steam Turbine Developments. W. L. R. Emmet. Abridgement of a paper presented to the Nat. Elec. Lgt. Assn. Considers the aims of recent designs of Curtis turbines, showing the progress that has been made. 2500 w. Eng Rec—June 22, 1907. No. 85199.

First Rateau Regenerator Installed in America. F. G. Gasche. Description and test of the Rateau low-pressure turbine system at the works of the International Harvester Co., Chicago, Ill. 4000 w. Power—June, 1907. No. 84653 C.

The Steam Turbine. Leo A. Phillips. Considers particularly the Westinghouse-Parsons type of turbine, illustrating and describing its construction, its performance and commercial features. General discussion. 10500 w. Pro Ry Club of Pittsburgh—Feb. 22, 1907. No. 84662 C.

Turbines. A brief account of the necessary care to be exercised in the operation of turbines for driving generators, the two most important points being efficient lubrication and good steam. 1200 w. Elec Rev, Lond—May 25, 1907. No. 84750 A.

Is a 200 Horse Power Steam Turbine Plant Economical? (Ist eine 200 Pferdige Dampfturbinenanlage Wirtschaftlich?) W. A. Müller. Compares the small steam turbine with the piston engine of the same power as regards both first cost and operating expenses. Tables. 1500 w. Zeitschr f d Gesamte Turbinenwesen—May 20, 1907. No. 84953 D.

Valve Setting.

How to Set a Riding Cut-off Valve. Hubert E. Collins. An illustrated article giving the principal points which engineers ought to know about the action of the well-known Meyer valve. 4000 w. Power—June, 1907. No. 84651 C.

Water-Softening.

A Commonplace View of Water-Softening. E. J. Deason. Discusses water and its impurities in connection with steam engineering, and plants and processes for their removal. 3000 w. Ir & Coal Trds Rev—May 24, 1907. No. 84763 A.

Commercial Water Softening and Purification. Charles M. Hampson. From Pro. Colo. Sci. Soc. Reviews briefly successful processes for purifying and softening water and shows the saving made by purifying feed water before it enters the boilers. 2000 w. Min Rept—June 6, 1907. No. 84860.

MISCELLANY.

Aeronautics.

The Wellman Polar Airship Expedition. Illustrates and describes the arrangements made for the expedition. 2500 w. Sci Am—June 22, 1907. No. 85161.

Aeronautics in Foreign Countries (L'Aéronautique à l'Etranger). G. Espitallier. Describes the section devoted to aeronautics at the Milan Exposition in 1906 and discusses the experiments being carried on in the Italian Army. Ills. 2800 w. Génie Civil—May 4, 1907. No. 84907 D.

Air Bar.

The Compressed Air Bar. A. C. Musehold. Explains the uses of this invention for storing compressed air, with illustrated description. 1000 w. Compressed Air —June, 1907. No. 85260.

Bottle-Making.

The Leistner Bottle-Making Machine. A machine for the manufacture of glass bottles is illustrated and described, and also its operation. 3500 w. Engng—June 7, 1907. No. 85115 A.

Eighteenth Century.

Mechanical Masterpieces of the Eighteenth Century. Dr. Alfred Gradenwitz. An account of the work of Pierre Jaquet-Droz and his son, Henri Louis. Illustrates and describes three famous automatons. 1600 w. Sci Am—June 22, 1907. No. 85162.

Injuries to Vegetation.

Search for the Causes of Injury to Vegetation in an Urban Villa Near a Large Industrial Establishment. Persifor Frazer. Describes the investigation made and gives the conclusions. Also a bibliography of treatises on injuries to vegetation by furnace gases. 28000 w. Bul Am Inst of Min Engrs—May, 1907. No. 85270 D.

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MINING AND METALLURGY

COAL AND COKE.

Canada.

Notes on the Mineral Fuel Supply of Canada. R. W. Ells. Discusses mineral fuels which include other substances than coal, the location of deposits, etc. 1200 w. Can Min Jour—June 15, 1907. Serial. 1st part. No. 85217.

Charcoal Burning.

Composition of Gas Given Off in Charcoal Burning (Gasverhältnisse bei der Holzverkohlung). Eduard Juon. Gives the results of elaborate experiments carried out in Russia. Tables. Serial. 2 parts. 6300 w. Stahl u Eisen—May 22 and 29, 1907. No. 84940 each D.

Coke.

Judging Coke from Its Appearance. A Thau. Trans. from *Glückauf*. Illustrates and explains the exterior characteristics of coke, from which the percentage of ash, volatile matters and water may be approximately ascertained, and other information of value. 3000 w. Ir & Coal Trds Rev—May 24, 1907. No. 84765 A.

Peat Coke. Max Toltz. Information concerning the deposits of peat, the making of peat coke, the by-products and their use. 3500 w. Jour Assn of Engng Socs—May, 1907. No. 85142 C.

Why Is It That Some Coals Coke and Others Do Not? Fred C. Keighley. Read before the Coal Min. Inst. of America. A discussion of the coking properties of coals. 6500 w. Ind Wld—June 22, 1907. No. 85212.

Coke Ovens.

Notes on By-Product Coke Ovens with Special Reference to the Koppers Oven. A. Victor Kochs. Read before the Inst. of Min. Engrs. Explains the design and construction of the coke-oven invented by Heinrich Koppers, of Essen, Germany. Ills. 5500 w. Ir & Coal Trds Rev—June 14, 1907. No. 85253 A.

A By-Product Coking Plant at Clay Cross. W. B. M. Jackson. Read before the Inst. of Min. Engrs. Illustrated description of a Simplex By-product Coke oven plant, using a compressor. 3000 w. Ir & Coal Trds Rev—June 14, 1907. No. 85250 A.

Colliery Equipment.

Operation and Equipment of the St. Clair Colliery. Floyd W. Parsons. Outside machine is driven by steam, while underground equipment is electrically driven. Ills. 1500 w. Eng & Min Jour—June 15, 1907. No. 85054.

Colorado.

The Coals of Routt County, Colorado. Arthur Lakes. Information in regard to this district, the character of the coals, especially considering the Yampa field. Map. 3000 w. Min Wld—June 15, 1907. No. 85084.

Composition.

The Composition of Coals. Frank F. Grout. Presents a graphical comparison of the chemical analyses of coals, giving classification and application to coals of United States. 4500 w. Ec Geol—April, 1907. No. 85185 D.

Electric Power.

An Alternating-Current Coal-Mining Installation. T. W. Sprague and C. K. Stearns. Illustrated description of a central power station in West Virginia, with high potential transmission and transformers where required. 2500 w. Eng & Min Jour—June 8, 1907. No. 84841.

Explosions.

Colliery Explosions and Their Causes. James T. Beard. Considers some of the many causes, believing seismic forces to be more important than barometric changes. Ills. 4000 w. Eng & Min Jour—June 1, 1907. No. 84710.

Barometric Pressure and Simultaneous Explosions of Gas in European Collieries. M. Mascart. Trans. from *Echo de Mines*. Gives information in regard to the barometric pressure at the time of the explosions at Reden, Germany, and Liévin, France, which occurred nearly simultaneously. Seems to show that a rapid fall of the barometer has an influence. Also editorial. 1500 w. Eng & Min. Jour—June 1, 1907. No. 84711.

Outbursts of Coal and Gas in the Cockshead Seam. An account of occurrences at Hanley. Full abstract of F. E. Buckley's paper before the N. Staffordshire Inst. of Min. & Mech. Engrs. Discussion. 2700 w. Ir & Coal Trds Rev—June 7, 1907. No. 85121 A.

Colliery Experimental Work of the Geological Survey. Clarence Hall. From a paper read before the Coal Min. Inst. of America. An account of a plan for experimental investigations of explosives, safety lamps, rescue apparatus, and other matters relating to safety in mine working. 1200 w. Eng & Min Jour—June 22, 1907. No. 85224.

Urpeth Colliery Explosion. A review of Mr. J. B. Atkinson's report on an explosion of firedamp and coal dust, which

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occurred Dec. 17, 1906. Ills. 5000 w. Col Guard—June 7, 1907. No. 85110 A.

Machine Mining.

Economies of Coal Mining by Machine. George Farmer. A summary of the economies claimed to be effected by machine mining. 700 w. Min Rept—June 13, 1907. No. 85081.

Montana.

Montana Coal Mines. J. P. Rowe. Deals with the principal producing mines, extent of development, methods of mining and handling coal, and the machinery used. 4500 w. Mines & Min—June, 1907. No. 84737 C.

Safety Devices.

Government Tests of Safety Devices for Mines. A report of tests to be made by the United States government of the various dynamites and powders, and experiments in rescue work. 1800 w. Sci Am—June 8, 1907. No. 84821.

Surveys.

Methods Used in Surveys of Coal Mines. L. D. Tracy. Deals particularly with methods used in the bituminous mines in and near Pittsburg. Map. 3800 w. Eng News—May 30, 1907. No. 84694.

Utilization.

Recent Improvements in the Utilization of Coal. Marius R. Campbell. Discusses recent improvements, especially the utilization of soft coal, lignite and peat in the manufacture of producer gas for power purposes, giving the results of fuel-tests made at St. Louis. 1700 w. Ec Geol—June, 1907. No. 85189 D.

Warwickshire.

The Thick Coal of Warwickshire. J. T. Browne. Read before the Inst. of Min. Engrs. Deals particularly with the methods of working these coal seams. 1200 w. Ir & Coal Trds Rev—June 14, 1907. No. 85255 A.

Waste.

Investigations of the Waste in Mining and Preparation of Coal. Edward W. Parker. Presented before the Coal Min. Inst. of America. Explains the character of investigations to be made by the Geological Survey, of losses through wasteful methods of operation, the causes, etc. 2000 w. Eng & Min Jour—June 22, 1907. No. 85222.

COPPER.

Africa.

The Otavi Copper and Lead Mines. J. Hartley Knight. Map with description of the nature of the deposits, and the methods of mining and smelting. 1000 w. Eng & Min Jour—June 15, 1907. No. 85050.

Assaying.

The Use of Zinc in Assaying Copper Matte, etc. Donald M. Levy. Gives experiments showing that zinc effects a more complete separation than does aluminum in assaying materials containing copper and iron. 1000 w. Inst of Min & Met, Bul. 32—May 16, 1907. No. 85042 N.

Electro-Determination of Copper and Its Separation from Mercury and Silver. H. J. S. Sand. Describes methods used and experiments carried out. 900 w. Min Rept—June 13, 1907. No. 85080.

British Columbia.

The Dominion Copper Company, Limited. An interesting account of one of the Boundary District's most important copper producers, which is increasing its output. 3000 w. Min Jour—June 1, 1907. No. 84888 A.

Lake Superior.

Practice at the Osceola Mill, Lake Superior. Lee Fraser. An illustrated account of improved methods of handling pulp and the use of the Nordberg steeple-compound stamp, which have reduced costs at this copper mine to 16 cents per ton. 1600 w. Eng & Min Jour—June 22, 1907. No. 85218.

Mine Equipment.

Novel Equipment of Tywarnhaile Copper Mine. Edward Walker. Illustrates and describes the application of the Elmore vacuum process for concentrating tion works. Ills. 3000 w. Mines & Min Jour—June 1, 1907. No. 84706.

Nevada.

Copper Deposits at Ely, Nevada. William Starr Bullock. Information in regard to the rapid development of the mines and the construction of the reduction works. Ills. 3000 w. Mines & Min—June, 1907. No. 84741 C.

A Visit to Ely, Nevada. James W. Abbott. Illustrated description of the development of this copper district, once mined for gold. 2500 w. Min & Sci Pr—June 15, 1907. No. 85166.

Newfoundland.

Mining in Newfoundland. Day Allen Willey. Information concerning the extensive deposits of copper and iron ore and their development. Ills. 1000 w. Sci Am—June 8, 1907. No. 84822.

New Jersey.

Copper Deposits of the New Jersey Triassic. J. Volney Lewis. Briefly reviews the history of copper mining in New Jersey, describing the geology of the State, and studying the origin of the ores. 5000 w. Ec Geol—April, 1907. No. 85186 D.

Production.

Copper Production in 1906 and the Present Outlook. John B. C. Kershaw. An examination of the production figures for the past seven years with a view to discovering whether the mines now worked show any great power of increas-

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ing their output. 1700 w. Elec Rev, N Y —June 1, 1907. No. 84715.

Spain.

The San Vicinte Mine, Spain. Edward Walker. An account of a new copper mine, with map and plan. 800 w. Eng & Min Jour—June 22, 1907. No. 85220.

Texada Island.

The Marble Bay Copper Deposit. O. E. Leroy. Describes these deposits on Texada Island, B. C., their geology, origin, values, etc. 2800 w. Can Min Jour—June 15, 1907. No. 85215.

Uses.

Notes on Copper. Prof. A. Humboldt Sexton. The present article deals with the physical and chemical properties, commercial copper and its varieties, impurities, burnt copper, and the uses and value. Ills. 3000 w. Mech Engr—June 8, 1907. Serial. 1st part. No. 85097 A.

GOLD AND SILVER.

Assaying.

Method for Analysis of Gold-Silver Bullion. J. E. Clennell. Describes a rapid method for the approximate analysis of bullion. The elements to be determined are gold, silver, selenium, lead, copper, iron, and zinc. 2500 w. Eng & Min Jour—June 8, 1907. No. 84840.

Black Sands.

The Auriferous Black Sands of California. J. A. Edman. A brief statement of their origin, distribution and probable value. 2000 w. Eng & Min Jour—June 1, 1907. No. 84709.

Dredging.

Gold Dredging in Tierra del Fuego. Juan D. Roberts. An illustrated account of modern methods being introduced in this placer mining region. 800 w. Min Jour—June 1, 1907. No. 84889 A.

Flotation Process.

Acid Flotation Processes at Broken Hill. F. H. Jackson. Describes the practice in the Block 14 Mill, at Broken Hill, using the Potter process. 2000 w. Min & Sci Pr—June 8, 1907. No. 84866.

Malay States.

Gold and Tin Mines of the Federated Malay States, with Especial Reference to Pahang. J. B. Scrivenor. Information concerning the deposits, workings, methods, etc. Map. 5000 w. Min Jour—June 8, 1907. Serial. 1st part. No. 85108 A.

Mexico.

The Lluvia de Oro District, Mexico. R. H. Burrows. An illustrated account of this district and the discovery of the Lluvia de Oro gold mine, describing the topography, ore bodies, geological formation, etc. 2800 w. Min & Sci Pr—May 25, 1907. No. 84678.

The Mining District of Asientos, Mexico. Bruno Newman. Illustrated description of a district situated near two smelting plants which includes promising copper, lead, and silver deposits in rhyolite and limestone. 1500 w. Eng & Min Jour—June 1, 1907. No. 84708.

Milling.

Milling at Gladstone, Colo. George P. Scholl. Describes tube milling at the Gold King mill, and successful concentration of low-grade complex ore at the Mogul mill. Ills. 1800 w. Mines & Min—June, 1907. No. 84740 C.

Montana.

Early Mining History of Montana. K. T. Harmond-Fogarty. A review of the early history of mining and of the difficulties in developing the gold and silver mines. 3500 w. Min Wld—June 8, 1907. No. 84832.

Nevada.

Goldfield, Nevada. An illustrated review of this field and its development, reporting the extreme richness of the deposits. 1500 w. Min & Sci Pr—June 8, 1907. No. 84863.

Gold Tellurides. W. J. Sharwood. Gives drawings of thin sections showing two modes of occurrence of these ores at Goldfield, Nevada. 500 w. Min & Sci Pr—June 8, 1907. No. 84867.

Water Resources of Nevada. Henry Thurtell. An account showing the available supply of water, which is so much needed for the working of gold and silver mines and for domestic purposes. Ills. 3000 w. Min & Sci Pr—May 25, 1907. No. 84677.

New Zealand.

The Undeveloped Gold-Deposits of New Zealand. W. Green. Suggestions for future development, giving results of investigations and study of the geology of the gold-deposits of the colony. 8500 w. N Z Mines Rec—April 16, 1907. No. 84899 B.

Nova Scotia.

The Richardson Mine. Percy Brown. History and illustrated description of this gold mine in Nova Scotia. 1700 w. Can Min Jour—June 15, 1907. No. 85216.

Ontario.

New Silver District in the Temagami Reserve. L. H. Mattair. Brief account, with map showing location of what promises to be a rich district. 600 w. Eng & Min Jour—June 15, 1907. No. 85051.

Queensland.

Some Croydon Gold Mines. B. Dunstan. Information concerning recent investigations made of these mines, especially with reference to Bennion's reef and the Highland Mary reef. Ills. 5500 w. Queens Gov Min Jour—May 15, 1907 No. 84871 B.

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Stamp Mill.

Notes on a Modern Stamp Mill. Gilmour E. Brown. Describes two stamp mills and their work, the ore, the treatment, and gives general information. Ills. 4500 w. Inst of Min & Met, Bul. No. 32—May 16, 1907. No. 85041 N.

Tube Mills.

Notes on Some Recent Improvements in Tube Mill Practice. Kenneth L. Graham. Suggests some improvements recently occurring to the author which affect the economics of tube milling. 3500 w. Jour Chem, Met, & Min Soc of S Africa—April, 1907. No. 85093 E.

IRON AND STEEL.

Analysis.

Report of Committee on Standard Methods for the Analysis of Iron. Presented to the Am. Found. Assn. Gives methods for determining graphitic carbon, manganese, and phophorus. 1800 w. Ir Trd Rev—June 6, 1907. No. 84736.

Blast Furnaces.

Blast Furnace Practice. T. F. Witherbee. Discusses the papers of F. L. Grammer, and of J. E. Johnson, Jr. 5000 w. Bul Am Inst of Min Engrs—May, 1907. No. 85274.

The Gas-Producer as an Auxiliary in Iron Blast-Furnace Practice. R. H. Lee's paper is discussed. Ills. 1200 w. Bul Am Inst of Min Engrs—May, 1907. No. 85275.

Electric Furnace.

See Electrical Engineering, Electro-Chemistry.

Flue Dust.

The Settling and Collection of Dust in Flues. L. S. Austin. Considers the principles applicable to the settling of dust accompanying the gases from furnaces, and their analogy to the settling of sand and slime in settling tanks. 800 w. Min & Sci Pr—May 5, 1907. No. 84679.

Gas Meters.

The Measurement of Large Quantities of Gas by the Manometer (Messung Groszer Gasmengen mittels Differenzdruckes). E. Stach. Illustrates and describes a method of measuring the gas delivered from blast furnaces and coke ovens by recording manometers. Diagrams. 2000 w. Stahl u Eisen—May 1, 1907. No. 84936 D.

Minnesota.

Developments in the Colerine District. An illustrated account of the character and size of the ore deposits in these iron mines, the new development, etc. The Gilbert mine is described. 2000 w. Ir Trd Rev—June 20, 1907. No. 85148.

Nomenclature.

Uniform Nomenclature for Iron and Steel (Einheitliche Benennung von Eisen und Stahl). Dr. H. Wedding. Discusses the work of the International Congress for the Testing of Engineering Materials at Brussels in 1906, with table showing where a uniform nomenclature should be adopted. 3000 w. Stahl u Eisen—May 29, 1907. No. 84942 D.

Ore Reserves.

Iron Ore Reserves of the United States. John Birkinbine. A comparison of American supplies with European resources. A review of the iron ore situation in the United States. 2500 w. Cassier's Mag—June, 1907. No. 85179 B.

Pyrite.

The Oxidation of Pyrite. Alexander N. Winchell. Describes an attempt to produce experimental evidence that natural circulating waters will oxidize pyrite. 1200 w. Ec Geol—April, 1907. No. 85190 D.

Rolling Mill.

A Modern Mill (Ein Modernes Platinen-Triowalzwerk). Illustrated description of a plant at Jünkerath, Germany. Plate. 1500 w. Stahl u Eisen—May 8, 1907. No. 84937 D.

Scrap.

The Growth of the Scrap Movement. B. E. V. Luty. Shows the growth of scrap consumption, the uses; describes the re-rolling operations, and other processes of interest. 3500 w. Ir Trd Rev—May 30, 1907. No. 84676.

Stassano Furnace.

The Stassano Thermo-Electric Furnace. Ernest Stassano. Illustrates and describes two furnace types, which produce malleable steel with a thermal efficiency of more than 50 per cent. 2200 w. Eng & Min Jour—June 15, 1907. No. 85048.

Steel Works.

The Blast-Furnace, Steel, and Rolling-Mill Plant of the "Società Anonima degli Alti Forni e Fonderia di Piombino" (Die Hochofen-, Stahl-, und Walzwerksanlage der "Società Anonima degli Alti Forni e Fonderia di Piombino"). Fritz Lürmann. Illustrated description. 2100 w. Stahl u Eisen—May 1, 1907. No. 84935 D.

Gas and Electric Power in Continental Iron and Steel Works. J. B. van Brussel. Reviews some of the most important economies which have been applied in Europe in the manufacture of iron and steel. Ills. 2800 w. Engineering Magazine—July, 1907. No. 85305 B.

Structure.

Change of Structure in Iron and Steel. William Campbell. Considers the changes which take place in the iron-carbon series, as disclosed by recent investigations. Ills. 4000 w. Jour Fr Inst—June, 1907. No. 85137 D.

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Virginia.

The Virginia Iron Industry. John J. Porter. A discussion of the past history, present conditions, and future prospects. 5000 w. Mfrs Rec—June 27, 1907. Serial. 1st part. No. 85288.

MINING.

Boring.

The Causes of the Deflection of Deep Boreholes from the Perpendicular (Die Ursachen der Abweichung der Tiefbohrungen vom Lot). Albert Fauck. Illustrated discussion with numerous examples. 1500 w. Oest Zeitschr f Berg u Hüttenwesen—May 11, 1907. No. 84944 D.

An Underground Camera. J. T. Atwood. Illustrates and describes a camera designed for photographing the sides of bore holes. 2200 w. Wis Engr—June, 1907. No. 85129 D.

Debris Commission.

Hydraulic Mining and the Federal Government in California. William W. Harts. An illustrated account of the work of the Débris Commission on the Yuba and other rivers. 1500 w. Mines & Min—June, 1907. No. 84738 C.

Diamonds.

The Premier Diamond Mine, Transvaal, South Africa. R. A. F. Penrose, Jr. Describes the general features of the diamond deposits in South Africa, and gives illustrated description of the Premier mine. 2500 w. Ec-Geol—April, 1907. No. 85188 D.

Electricity.

Electricity in Mines (La Electricidad en las Minas). Emilio Guarini. Discusses the general consideration attending its installation and its application to lighting, communication, traction and motive power problems. 10000 w. Anal Sociedad Cien Argen—Dec., 1906. No. 84933 F.

Hoisting.

Temporary Whim for Hoisting. Guy C. Stoltz. Brief illustrated description of a whim built for temporary hoisting at Mineville, N. Y. 500 w. Eng & Min Jour—June 15, 1907. No. 85047.

Lane Mill.

Conclusive Test of Lane Mill. J. A. Stewart. Gives information acquired from a test made in the State of Washington. 1000 w. Min Rept—June 13, 1907. No. 85083.

Mine Locomotives.

Tests with Various Types of Mine Locomotives (Versuche mit Grubenlokomotiven Verschiedener Systeme). Herr Wex. Gives results of elaborate tests, under service conditions, of benzol, benzine and electric locomotives, the latter including both accumulator and trolley types. Ills. Serial. 2 parts. 11000 w. Glückauf—May 4 and 11, 1907. No. 84959 each D.

Mineral Wax.

The Ozokerite (Mineral Wax) Mine of the Galizische Kreditbank, at Borys-law, Galicia, Austria. D. M. Chambers. Read before the Inst. of Min. Engrs. Describes wax-mining and treatment. 900 w. Ir & Coal Trds Rev—June 14, 1907. No. 85252 A.

Organization.

Suggestions for Mine Staff Organization. J. Boyd Aarons. Gives a plan for apportioning duties and responsibilities of members of the operating force and conducting the work of the departments of a mine staff, particularly a gold mine. 2500 w. Eng & Min Jour—June 22, 1907. No. 85221.

Phosphate.

The Mining of Phosphate in Northern France (Der Abbau der Phosphate in Nordfrankreich). O. Tietze. Illustrated description of the deposits and mining methods. 2000 w. Glückauf—May 25, 1907. No. 84961 D.

Quicksilver.

Native Methods of Mining and Smelting Quicksilver Ore in Kweichow, China. Henry Brelich. Notes relating to the wages, prices, exchange, coinage, laws and customs used by the natives in quicksilver mining. 4800 w. Cassier's Mag—June, 1907. No. 85181 B.

Records.

Costs, Methods, and Records. W. A. MacLeod. Considers how far such records should be carried in the case of small or medium-sized mines. 3000 w. Queens Gov Min Jour—May 15, 1907. No. 84872 B.

River Channels.

The Ancient River Channels of California. George W. Kimble. A short study of this interesting subject. 700 w. Min & Sci Pr—June 8, 1907. No. 84865.

Salt.

Salt Mining Near Fleetwood. Fred. J. Thompson. Abstract of a paper and discussion before the Manchester, Eng., Geol. & Min. Soc. A sketch of the history and geology of the rock-salt deposit at Peersall, describing the methods of shaft-sinking and mining, and the Peersall salt-mine. 3000 w. Col Guard—May 24, 1907. No. 84756 A.

Shaft Sinking.

The Freezing Plant at the Klein-Rosseln Mine at Stieringen, Lorraine (Die Gefrierschacht-Anlage der Grube Klein-Rosseln bei Stieringen, Lothringen). Herr Jüngst. Illustrated description of methods used for sinking through quicksand, describing the freezing process, machines, etc. 1500 w. Glückauf—May 25, 1907. No. 84962 D.

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Siberia.

Siberian Mines and Mining Conditions. A. L. Simon. Notes of the history, climate, traveling conditions, mining laws, the different districts; the iron mines, placer mining, copper mines, prospecting, labor conditions and related subjects. 10000 w. Inst of Min & Met, Bul. No. 32—May 16, 1907. No. 85040 N.

Sulphur.

The Wonderful Sulphur Mines of Louisiana. Illustrated description of remarkable deposits near the coast of the Gulf of Mexico, and the interesting methods adopted for the recovery. 1600 w. Sci Am—June 1, 1907. No. 84674.

Surveying.

Mine Surveying and Geodetic Instruments of Prof. O. Cséti (Markscheiderische und Geodätische Instrumente vom Prof. O. Cséti). Eduard Dolezal. Illustrates and describes new and improved instruments invented by Prof. Cséti of the Royal Hungarian College of Mines. Serial. 1st part. 3000 w. Oest Zeitschr f Berg u Hüttenwesen—May 18, 1907. No. 84945 D.

Tunnels.

The Cost of a Small Rock Tunnel. Francis L. Pruyn. Discusses items of expense which should be considered in a cost estimate for such work. 1100 w. Compressed Air—June, 1907. No. 85261.

Ventilation.

Statical Experiments in Air Measurement at the Hermine Shaft of the Kohlwald Mine (Statische Wettermessungsversuche auf Hermineschacht der Grube Kohlwald). Herr Seidl. Gives numerous tables of the results of elaborate tests on the circulation of air in mines with formulæ. Ills. 3500 w. Glückauf —May 18, 1907. No. 84960 D.

MISCELLANY.

Aluminum.

The Metallurgy of Aluminum in 1906. Joseph W. Richards. A review of the industry showing that the demand exceeds the supply, and that the output for 1907 will probably be several times as great as 1906. Ills. 2800 w. Eng & Min Jour—June 8, 1907. No. 84836.

Assay Furnaces.

A Comparison of Coal and Oil Muffle Furnaces. George J. Young. Plan and sections, with temperature curves and report of the test. 700 w. Min & Sci Pr—June 1, 1907. No. 84770.

Graphite.

Canadian Graphite. H. P. H. Brumell. An account of this industry, describing the character of the graphite, the methods of treatment, and discussing the demands, uses, etc. Ills. 6400 w. Can Min Jour—June 1, 1907. No. 84834.

Gypsum.

Gypsum in Sussex. W. J. Kemp and G. Alfred Lewis. Read before the Inst. of Min. Engrs. Describes the deposits, the plaster manufacture, and the mines. 2500 w. Ir & Coal Trds Rev—June 14, 1907. No. 85254 A.

Joplin, Mo.

Origin of Lead and Zinc Ore Bodies in Joplin, Missouri, District. Otto Ruhl. Points out the structural features that determine the method of ore deposition in this field. Maps. 3500 w. Min Rept —June 20, 1907. No. 85228.

Lime.

The Manufacture of Lime and of Carbonic Acid Gas in the Chemical Industry (La Fabrication de la Chaux et du Gaz Carbonique dans l'Industrie Chimique). E. Nihoul. The first instalment discusses several types of lime-burning furnaces, methods of firing, operation, products, etc., both theoretically and practically. Ills. Serial. 1st part. 8400 w. Bull Sci d l'Assn des Elèves—April, 1907. No. 84903 D.

Magmas.

Magmatic Emanations. Francis Church Lincoln. A statement of what is known in regard to these emanations and their bearing on ore deposits. 4000 w. Ec Geol—April, 1907. No. 85187 D.

Mica.

Mica in Ontario. E. T. Corkill. Reviews the mica mining industry of Canada, describing the peculiarities of the deposits and the Smith mine. Ills. 1800 w. Can Min Jour—June 15, 1907. No. 85214.

Mining Law.

The Reform of the United States Mineral Land Law. R. W. Raymond. Discusses the mineral-land laws, the attempts at reform, and the remedy for present abuses. 1500 w. Eng & Min Jour—June 8, 1907. No. 84839.

Mining Sociology.

A Brief Study of Social Conditions in the Bituminous Coal Region of Pennsylvania. C. L. Fay. Read before the Coal Min. Inst. of America. Discusses briefly the classes of a mining town and their relation to each other, and the remedies for undesirable conditions. 1200 w. Eng & Min Jour—June 22, 1907. No. 85223.

Oil Fields.

Sketch of the Oil Fields of Colorado. Arthur Lakes. Reviews the oil possibilities in Colorado, giving information in regard to the productive fields, the quality of the oil, and the future outlook. 1400 w. Min Wld—June 1, 1907. No. 84720.

New Russian Oilfields: The Northern Caucasus and the Petchora Basin. Reports rich oilfields in the Kubansky Ob-

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last. 1500 w. Min Jour—June 18, 1907. No. 85109 A.

Pipe Line.

Proposed Long Rifled Pipe Line for California Oil. Describes a new line, 256 miles long, extending from Delano to Porta Costa. Diagram. 1000 w. R R Gaz—June 7, 1907. No. 84806.

Platinum.

Platinum Supply and Demand. E. de Haupick. Information in regard to the production, prices, localities, etc. 1200 w. Min Wld—June 8, 1907. No. 84833.

Settling Velocities.

Velocity of Galena and Quartz Falling in Water. Robert H. Richards. Supplementary to former papers by the author on Close Sizing Before Jigging, and Sorting Before Sizing. 4800 w. Bul Am Inst of Min Engrs—May, 1907. No. 85271 C.

Tin.

A Tin Deposit Near Spokane. A. R. Whitman. An account of a seemingly rich deposit almost in the suburbs of this mining city. 1800 w. Min & Sci Pr—June 1, 1907. No. 84769.

Revival of the South Crofty Tin Mines, Cornwall. Edward Walker. An illustrated account of reorganization. A number of small mines will be worked by one corporation, introducing new equipment and new methods. 1000 w. Eng & Min Jour—June 8, 1907. No. 84838.

The Tasmanian Tin Industry. Ralph Stokes. An illustrated article describing the deposits, and the geological and industrial features of interest. 2200 w. Min Wld—June 8, 1907. Serial. 1st part. No. 84831.

Veins.

The Formation and Enrichment of Ore-Bearing Veins. George J. Bancroft. The relationship between "porphyry" and ore is discussed and the views of the writer explained in detail. 8000 w. Bul Am Inst of Min Engrs—May, 1907. No. 85273 C.

Mutual Displacement by Intersecting Veins. Walter Harvey Weed. Illustrations showing peculiar seams which may explain faulting on a larger scale. 600 w. Eng & Min Jour—June 15, 1907. No. 85052.

RAILWAY ENGINEERING

CONDUCTING TRANSPORTATION.

Derailments.

One Cause of Derailments. W. R. M'Keen, Jr. Editorial, discussing the proper location of side bearings, together with the amount of vertical clearance between them. 1100 w. R R Gaz—June 14, 1907. No. 85072.

A Possible Cause for Wrecks. H. M. Perry. Discusses derailments due to excessive loads on side bearings. 1200 w. Ry Mas Mech—June, 1907. No. 84827.

Facilities.

Necessary Expansion of Railroad Facilities. From an address before the Chamber of Commerce at Syracuse, N. Y. Showing the rapid increase in the commerce of the nation and the need of great increase of facilities, and matters bearing upon railroad operation. 2000 w. Ry & Engng Rev—June 22, 1907. No. 85230.

Oscillations.

The Oscillations of Rolling Stock at High Speeds (Les Oscillations du Matériel dues au Matériel lui-même et les Grandes Vitesses des Chemins de Fer). Georges Marié. The first instalment deals with oscillations due to the unbalanced reciprocating parts of locomotives and to tapered tires. Mathematical discussion with practical illustrations. Ills. Serial. 1st part. 18500 w. Rev Gen des Chemins de Fer—May, 1907. No. 84902 G.

MOTIVE POWER AND EQUIPMENT.

Air Brakes.

Recent Development in Air Brake Control Apparatus. F. H. Parke and S. W. Dudley. An illustrated discussion of recent rapid developments and fundamental changes in the control apparatus and the requirements to be met. 3000 w. R R Gaz—June 9, 1907. Serial. 1st part. No. 84811.

The Value of Straight Air Brakes. Describes the straight air-brake system, discussing the cost and maintenance, etc. 1400 w. Elec Ry Rev—June 15, 1907. No. 85078.

Air Brakes on the New York Central Electrical Equipment. Extracts from a paper by S. W. Dudley, read at Columbus, Ohio. Describes the brake equipment and its operation. Diagrams. 3000 w. Ry & Engng Rev—June 1, 1907. No. 84730.

The Westinghouse Improved High Speed Brake on the Santa Fe. An account of the development of the Westinghouse brake, referring to the various equipments which have been used by the Santa Fe and the dates when they were applied. 3500 w. Ry Age—May 31, 1907. No. 84729.

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Car Repairs.

The Cost of Freight Car Repairs. M. K. Barnum. Gives a form, classifying the cost of repairs, aiming to keep a record that will make possible keeping down the cost which has been constantly increasing. 500 w. R R Gaz—June 14, 1907. No. 85075.

Cars.

Steel Passenger Equipment. Charles E. Barba and Marvin Singer. The first of a series of articles aiming to advance methods by which the fundamental laws and principles governing the action of the structural materials, under simple and combined stresses, may be applied to the design of steel passenger equipment so as to secure maximum strength with minimum weight. 3000 w. Am Engr & R R Jour—June, 1907. Serial. 1st part. No. 84784 C.

All Steel Passenger Service Cars. Explains the reasons for building steel cars and illustrates and describes the design adopted by the Pennsylvania Railroad. 2800 w. Am Engr & R R Jour—June, 1907. No. 84790 C.

Steel Passenger Cars on the Pennsylvania Railroad. Briefly outlines the development in passenger cars, aiming to increase strength and lessen cost of maintenance, and gives an illustrated description of types of steel cars under construction for the Pennsylvania R. R. 3700 w. Ry Age—June 7, 1907. Serial. 1st part. No. 84829.

Steel Passenger Cars for the Pennsylvania Railroad. Gives illustrated description of the general types of steel passenger equipment adopted, 200 cars having been ordered. 5000 w. R R Gaz—June 14, 1907. No. 85077.

Structural Steel in Freight Car Construction. G. A. Akerlind. Read before the Scandinavian Tech. Soc., in Chicago. Reviews the development and calls attention to strong features, discussing design. Ills. 3500 w. Ry & Engng Rev—June 15, 1907. No. 85086.

An 80-Ft. Flat Car Trussed with Steel Cables. Illustrates and describes cars built for the Belgian Lines of the Northern Railway of France for carrying long rails. States the requirements. 700 w. Eng News—June 13, 1907. No. 85026.

75-Ton Steel Flat Car. Brief illustrated description of a car for carrying heavy machinery, castings, etc., built for the Lake Shore & Michigan Southern Railway. 600 w. Am Engr & R R Jour—June, 1907. No. 84787 C.

Steel-Frame 50-Ton Gondola Cars: Wabash Railway. Plans and description of high-capacity cars for coal and freight service in which a very substantial steel underframe is used, with sides, ends and floor of timber. 1200 w. Eng News—June 13, 1907. No. 85024.

A New Clearance-Measuring Car for the Baltimore & Ohio R. R. J. H. Milburn. Briefly describes previous methods of measurement and gives illustrated description of a new car for this work. 2500 w. Eng News—June 13, 1907. No. 85023.

Compression.

Compression in Locomotive Cylinders and Means for Its Relief. H. G. Manning. Calls attention to compression in locomotive engine cylinders as demonstrated by the St. Louis tests, the means of relief and the benefits. 2500 w. R R Gaz—June 7, 1907. No. 84807.

Connectors.

Automatic Connectors for Air and Steam. Illustrated descriptions of the principal types of connectors for air and steam pipes now in use. 1700 w. Ry Mas Mech—June, 1907. No. 84828.

Dynamometers.

A New Railway Car Dynamometer. A. H. Emery, Jr. Illustrates and describes an instrument for recording the pull or push between the locomotive and train. Explains the records made, the general principles of the apparatus, etc. 3500 w. Am Mach—Vol. 30, No. 22. Serial. 1st part. No. 84680.

Some New Dynamometers (Circa Alcuni Nuovi Dinamometri). Federigo Giordano. The first instalment illustrates and describes several forms of traction dynamometer. Serial. 1st part. 5500 w. L'Industria—May 19, 1907. No. 84923 D.

A Recording Machine for Dynamometer Tests on Railway Trains. An illustrated description of the machine and the record made, while in use by the railway department of the International Correspondence Schools. 2000 w. Eng News—June 6, 1907. No. 84816.

Electrification.

The Electrification of the West Shore Railroad between Utica and Syracuse. An illustrated account of this recently completed work and of the service proposed. 3000 w. Elec Rev, N Y—June 22, 1907. No. 85211.

West Shore Electrification Between Utica and Syracuse. Explains the reasons for the methods adopted in this undertaking, and gives an illustrated detailed description of the electric system, transmission lines, etc. 5000 w. St Ry Jour—June 8, 1907. No. 84842.

Fireboxes.

Locomotive Fireboxes with Expansion Side Sheets. Describes the Langbridge firebox, with illustrations and report of their use. Also editorials. 2000 w. Eng News—June 20, 1907. No. 85159.

We supply copies of these articles. See page 845.

Locomotive Lubrication.

Recommendations as to Practice in Locomotive Lubrication. Report of committee at the convention of the Ry. Mas. Mechs.' Assn. 800 w. Eng News—June 20, 1907. No. 85157.

Locomotive Performance.

Ton-Mile-Per-Hour. G. H. Windsor. Discusses the question of fair rating of locomotive performance. Ill. 1200 w. Ry & Loc Engng—June, 1907. No. 84774 C.

Locomotives.

British Locomotives in 1906. Charles Rous-Marten. Reviews the main features of British locomotive practice and performance for the year just ended. Ills. 6300 w. Bul Int Ry Cong—May, 1907. No. 85289 E.

Some Remarkable Locomotives of 1906. J. F. Gairns. Illustrated descriptions of selected locomotives. 3000 w. Cassier's Mag—June, 1907. No. 85183 B.

Articulated Locomotives for Road Service on Great Northern Ry. Illustrated detailed description of engines for heavy service. 800 w. Ry & Engng Rev—June 8, 1907. No. 84861.

DeGlehn Compound for the Paris-Orleans Railway. Illustrated description of a type of which 20 have recently been built in America on the metric system of measurements. 2000 w. R R Gaz—June 7, 1907. No. 84802.

Four-Cylinder Compound Express Locomotive for the Danish State Railway. Illustrations and dimensions of an interesting type of engine. Plate. 200 w. Engng—June 14, 1907. No. 85243 A.

Mallet Compound Freight Locomotive. Illustrated detailed description of engines for the Great Northern Railway. 900 w. Am Engr & R R Jour—June, 1907. No. 84785 C.

Pacific Locomotive for the Atlanta & West Point. Illustrated description of 4-6-2 locomotives which are excellent examples of modern heavy passenger engines. 1200 w. R R Gaz—June 7, 1907. No. 84805.

Pacific Type Locomotive for Heavy Express Service on the Pennsylvania R R. Brief illustrated description of an engine weighing 173,550 lbs. just put in service. 400 w. Eng News—June 20, 1907. No. 85152.

Simple Ten-Wheel Locomotive. Illustrated description of locomotive equipment for the Chicago & Northwestern Railway. A simple ten-wheel locomotive with Walschaert valve gear is shown. 900 w. Am Engr & R R Jour—June, 1907. No. 84793 C.

Six-Coupled Bogie Tank Locomotive; Midland Railway. General view and sectional elevation, with description. 700 w. Engng—May 31, 1907. No. 84892 A.

New Locomotives for the Italian State Railways (Nuove Locomotive delle Ferrovie Italiane di Stato). Illustrated detailed description of new rolling stock. Serial. 1st part. 3000 w. Il Monitore Tech—May 20, 1907. No. 84925 D.

Consolidation (2-8-0) Type, Compound Locomotive,—St. Gothard Railway. Illustrated description. 700 w. Mech Engr—June 22, 1907. No. 85379 A.

The Most Powerful Express Locomotive Ever Built. Illustrates the first and latest locomotives of the Pennsylvania Railroad, describing the most powerful engine built up to this time. 1200 w. Sci Am—June 29, 1907. No. 85312.

Milan.

Railway Exhibits at the Milan Exposition, 1906 (Die Eisenbahnbetriebsmittel auf der Ausstellung in Mailand 1906). Herr Metzeltin. Illustrated detailed description of locomotives, cars, etc., exhibited. 6500 w. Serial. 1st part. Zeitschr d Ver Deutscher Ing—May 14, 1906. No. 84977 D.

Steam and Electric Railway Traction Exhibit at the International Exposition at Milan, 1906 (Ueber die Fahrbetriebsmittel für Eisenbahnen und Straszenbahnen auf der Internationalen Ausstellung in Mailand, 1906). E. A. Ziffer. Detailed description of the various types of steam and electric locomotives exhibited. 6000 w. Mitt d Ver f d Förd d Lokal u Straszenbahnwesens—April, 1907. No. 84934 D.

Oil-Burning.

A Solution of the Oil-Burning Locomotive Problem. Harrington Emerson. Considers the differences between oil and coal burning, and the modifications necessary in oil-burning locomotives, describing the improved oil-burning methods introduced on the Santa Fè System and the results. 3000 w. R R Gaz—June 7, 1907. No. 84801.

Reports.

Master Car Builders' Reports. Gives report on tests of M. C. B. couplers, and abstracts of other important reports. Ills. 13500 w. R R Gaz—June 21, 1907. No. 85173.

Simplon.

Operating Arrangements of the Simplon Railway (Die Betriebseinrichtungen der Simplonbahn). Karl Pallasmann. Describes the lighting, ventilation, etc. Ills. 3000 w. Oest Wochenschr f d Oeff Baudienst—May 25, 1907. No. 84963 D.

Speed Control.

New Apparatus for Controlling the

We supply copies of these articles. See page 845.

Speed of Trains. H. P. Maas-Geesteranus. Illustrates and describes apparatus which has been in use for some time in Holland. 1900 w. Bul Int Ry Cong—May, 1907. No. 85291 E.

Superheating.

The Baldwin Superheater. Illustrated description of a locomotive, equipped with a smokebox superheater, which is being exhibited at Jamestown Exposition. 600 w. R R Gaz—June 7, 1907. No. 84803.

Simple Locomotive Fitted With Improved Smoke Tube Superheater. Wilhelm Schmidt. Illustrates and describes a Swiss locomotive fitted with the author's latest design of superheater, showing the tendency toward a higher degree of superheat. 2000 w. Am Engr & R R Jour—June, 1907. No. 84792 C.

Train Lighting.

The Verity Dalziel System of Train Lighting. Describes a system in which the lamps are supplied at a constant voltage, the regulation being effected by electrical apparatus. Ills. 2000 w. Elect'n, Lond—May 24, 1907. No. 84754 A.

Train Stop.

Phillips Automatic Train Stop. Illustrated description of an apparatus for automatically applying the brakes on a train, which has been in service in England for two years. 1200 w. R R Gaz—May 31, 1907. No. 84668.

Valve Gears.

Results of Use of Different Valve Gears on Locomotives. From the report of committee of the Am. Ry. Master Mechs.' Assn. Discusses valve-actuating mechanism and some systems of steam distribution. 1800 w. Eng News—June 20, 1907. No. 85153.

NEW PROJECTS.

Africa.

The Railways of the Upper Congo. Demetrius C. Boulger. An illustrated account of what the Belgians have accomplished, describing two railways constructed in Central Africa. 3800 w. Engineering Magazine—July, 1907. No. 85307 B.

China.

The Great Interior Trunk Line of China. An interesting illustrated account of the construction of the road to connect Peking and Canton. The Peking-Hankow portion is in operation. 2800 w. R R Gaz—June 21, 1907. No. 85174.

Great Central.

Great Central Railway Improvements. Describes the establishing of new connections requiring the widening of a bridge and the construction of a skew span bridge over a mill siding, and other schemes. 1200 w. Engr, Lond—May 31, 1907. No. 84897 A.

Panama R. R.

The Rebuilding and Double Tracking of the Panama R. R. R. Budd. Illustrated description of the work of rebuilding and double-tracking this railroad. 2000 w. Eng News—June 13, 1907. No. 85022.

Southern Pacific.

The Proposed Klamath Falls Line of the Southern Pacific. Illustrated description of a change of route in northern California and Oregon, which will give relief from heavy grades and curvature. 8000 w. R R Gaz—June 7, 1907. No. 84808.

Tehuantepec.

The Tehuantepec National Railway. Illustrated description of this reconstructed railway in Mexico, connecting ports on the Gulf of Mexico and on the Pacific Ocean, with information relating to it. 3000 w. Eng Rec—June 22, 1907. No. 85196.

PERMANENT WAY AND BUILDINGS.

Engine House.

An English Rectangular Engine House with Radial Tracks. Illustrated description of an engine house recently built at London, England, by the Great Western Ry. which is notable for the number of locomotives accommodated and the arrangement of the stalls. 1000 w. Eng News—June 13, 1907. No. 85025.

Freight Stations.

Remarks on Freight Stations in North America (Einige Bemerkungen über die Güterbahnhöfe in Nordamerika). Herrn Blum and E. Giese. Illustrates and describes freight terminal arrangements in several of the leading cities of the United States. 6000 w. Serial. 2 parts. Zeitschr d Ver Deutscher Ing—May 11 and 25, 1907. No. 84980 each D.

Gage.

Changing the Gage on the Louisville & Nashville. Reuben Wells. Describes the changing of gage from 5 ft. to standard (4 ft. 8½ in.) which was done in 1886. Diagrams. 2800 w. R R Gaz—June 7, 1907. No. 84804.

Maintenance Plants.

The Electrical Maintenance Plants of the New York Central & Hudson River Railroad Company. Illustrated detailed description of the shop construction of an electrified steam railroad, which is to care for the rolling stock used in the New York electric zone. 3500 w. St Ry Jour—June 8, 1907. No. 84843.

Rail Corrugation.

The Corrugation of Rails. Describes investigations carried out on the North-Eastern Railway, England, with table of tests. Ills. 2500 w. Engng—June 14, 1907. No. 85241 A.

We supply copies of these articles. See page 845.

Rails.

Concerning Rail Metal. Letters and editorial discussing the cause of breakage of steel rails and the remedy. 3000 w. Elec-Chem & Met Ind—June, 1907. No. 84777 C.

Open Hearth Steel Rails. Benjamin Talbot. Read before the Am. Soc. for Test. Mat. Gives results from the continuous open hearth process. 1500 w. Ir Age—June 27, 1907. No. 85294.

Standard Specifications for Steel Rails. Recommended by the Committee of the Am. Soc. for Testing Materials. 1200 w. Eng Rec—June 29, 1907. No. 85327.

The Steel Rail Discussion, American Society for Testing Materials. 9000 w. Ry & Engng Rev—June 29, 1907. No. 85360.

Shops.

A Few Specialties of the Elkhart Shops. Illustrates and describes interesting specialties introduced into these shops of the L. S. & M. S. Ry. 1800 w. Ry Mas Mech—June, 1907. Serial. 1st part. No. 84826.

Recent Shop Construction. Illustrates and describes the Burnside shops of the Illinois Central. 1800 w. R R Gaz—June 14, 1907. No. 85076.

Machine Tool Equipment of the E. P. & S. W. Ry. El Paso, Tex., Shops. Describes the machine tool equipment and layout of these shops. 2500 w. Ry & Engng Rev—June 8, 1907. No. 84862.

Signaling.

A New Signaling Machine System for the Automatic Control of Railroad Trains. Illustrates and describes the invention of Thomas E. Raymond Phillips, recently tested in England, which repeats in the engine cab, the signal of the semaphore, and blows the whistle, as well as gradually applying the brakes. 2000 w. Sci Am—June 15, 1907. No. 85013.

Station.

The Reconstruction of the Valenciennes Station (La Reconstruction de la Gare de Valenciennes). MM. Cossmann and E. Despono. The first number of the serial discusses the history of the Valenciennes station of the Northern Railway of France, and describes the general arrangement of the tracks, buildings and platforms of the new installation. Ills. Serial. 1st part. 3500 w. Rev Gen des Chemins de Fer—May, 1907. No. 84901 G.

Stubai.

The Stubai Valley Railway (Die Stubaitalbahn). A description of this railway in the Alps, giving plan and profile, details of construction and operation, etc. Serial. 1st part. 2500 w. Eisenbahntech Zeitschr—May 22, 1907. No. 84949 D.

Terminals.

Steam and Electric Locomotive Terminals of the New York Central at Croton and North White Plains. Illustrated detailed description of the extensive terminal facilities at these points where the change will be made from steam to electricity. 2000 w. R R Gaz—June 14, 1907. No. 85073.

Warehouses.

New Terminal Warehouses. Illustrates and describes the construction and equipment of the Illinois Central Railroad Company's building at New Orleans. 3000 w. Ins Engng—June, 1907. No. 85193 C.

Water Supply.

Water Supply of the Eastern Railway of New Mexico. William Archer. Describes the arrangement for the supply of boiler water along this line. Includes a 100,000-gallon tank, water pumped 1½ miles, distribution by water cars, treatment, etc. 3500 w. Ry Age—June 21, 1907. No. 85229.

TRAFFIC.

Car Shortage.

Address of Secretary Moseley to the M. C. B. Convention. Discusses car shortage and matters relating to it. 2500 w. R R Gaz—June 21, 1907. No. 85172.

Engine Loadings.

A Comparison of Cooper's E 50 Loading with Recent Heavy Locomotives. Gives a comparison compiled under the direction of C. F. Loweth, of the Chicago, Milwaukee & St. Paul Railway. 1000 w. Eng Rec—June 15, 1907. No. 85060.

Freight.

Science of Freight Transportation. C. L. Bardo. Discusses some of the essentials of good freight transportation. General discussion. 14000 w. Pro N Y R R Club—May 17, 1907. No. 85123.

Freight Cars.

Practical Means for Increasing the Earning Capacity of Freight Cars. J. E. Muhlfeld. Considers the classification of cars, their design, construction, repairs, inspection, loading and unloading, distribution and movement, etc., with reference to the present car shortage. Discussion. 21800 w. Pro Ry Club of Pittsburgh—March 22, 1907. No. 85122 C.

Freight Tariffs.

A Modern Tariff. Gives a recently issued tariff of the New York Central & Hudson River and West Shore railroads, covering charges for special freight train movements. An example of the complicated requirements of the present Interstate Commerce Commission rules for filing tariffs. 1500 w. R R Gaz—May 31, 1907. No. 84669.

We supply copies of these articles. See page 845.

MISCELLANY.

Accounting.
A Defective Accounting System. Editorial giving objections to the accountant's recommendations adopted by the Interstate Commerce Commission. 1800 w. R R Gaz—June 21, 1907. No. 85171.

Curvature.
Moment of Inertia and Curvature. G. R. Henderson. A study of the effect of the moment of inertia of an engine in being rotated about a vertical axis when entering a curve. Diagram. 2000 w. R R Gaz—June 7, 1907. No. 84809.

Italy.
A Glance at Railway Legislation (Uno Sguardo alla Legislazione Ferroviaria). A discussion of recent railway legislation in Italy. 5000 w. Boll Soc Ing e Arch Italiani—May 15, 1907. No. 84918 C.

The Management of the State Railway (L'Ordinamento delle Ferrovie di Stato). A synopsis of the legislation governing the organization and management of the Italian State Railway. 2200 w. Revista Gen d Ferrovie—May 12, 1907. No. 84922 C.

Organization.
Need for Getting Together on the Railroad Situation. J. W. Midgley. The first of a series of letters discussing the present railway situation and suggesting the organization of executive officers. 3300 w. Ry & Engng Rev—June 15, 1907. Serial. 1st part. No. 85087.

STREET AND ELECTRIC RAILWAYS

Boston.
Rapid Transit in Boston and Vicinity. Edward Hungerford. An account of present conditions and the plan for transit relief, extensions and improvements. Ills. 3000 w. Elec Ry Rev—June 1, 1907. No. 84727.

Brooklyn.
The Franklin Avenue Improvement on the Brighton Beach Line of the Brooklyn Rapid Transit Company. Re-alignment of an elevated section of about 1500 ft., with the erection of a new station, and remodeling of a junction station is illustrated and described. 1200 w. St Ry Jour—June 22, 1907. No. 85209.

California.
The Northern Electric Railway. An illustrated detailed description of an extensive interurban line in northern California, and of its equipment and operation. 2500 w. Elec Ry Rev—June 8, 1907. No. 84868.

Car-Meters.
Results Obtained by the Use of Car-Meters. M. Wattmann. Abbreviated translation of replies received in response to questions sent out, reporting results on the Continent. 5000 w. Elect'n, Lond —May 31, 1907. No. 84883 A.

Cars.
The New Steel Cars of the Hudson Companies. Hugh Hazelton. Illustrated detailed description of the rolling stock for lines running in tunnels under the Hudson River, and under city streets. 2200 w. St Ry Jour—June 8, 1907. No. 84844.

Car Wiring.
Car Wiring and Piping Practice of the Metropolitan West Side Elevated Railroad, Chicago. Illustrates and describes the wiring and arrangement of apparatus on fifty cars recently put in service. 1400 w. St Ry Jour—June 15, 1907. No. 85065.

Electric Traction.
The Philadelphia & Western Railroad. Illustrated detailed description of heavy electric traction for high-speed transportation. 6000 w. St Ry Jour—June 15, 1907. No. 85064.

Equipment.
The Effect of Topography, Tonnage and Time on Electric Railway Equipment. W. N. Smith. Considers these fundamental elements in their relation to the proportioning electrical equipment to the work to be done. 4500 w. Sib Jour of Engng—June, 1907. No. 85134 C.

Extension.
Ravenswood Extension of the Northwestern Elevated Railroad. Illustrated description of a new elevated structure near Chicago. 1000 w. Elec Ry Rev—June 22, 1907. No. 85225.

Feeders.
Direct-Current Feeder Calculations for Railways. Explains general principles, equally applicable to alternating-current feeders, giving formulæ. Diagrams. 2200 w. Elec Age—June, 1907. No 84771 C.

Gyroscope.
The Theory of the Gyroscope. An explanation of the theory, referring to its application to the Brennan mono-rail car. 1200 w. Engng—June 7, 1907. No. 85116 A.

Italy.
The Valle Brembana (Italy) Electric Railroad. C. L. Durand. Illustrated description of a standard-gauge, single-phase system used on a line connecting

We supply copies of these articles. See page 845.

Bergamo with San Giovanni Bianco, a distance of about twenty miles. 4000 w. Elec Rev, N Y—June 22, 1907. No. 85210.

London.

London United Electric Tramways. Historical account of the development of Sir Clifton Robinson's enterprise, with illustrated detailed description. 7500 w. Tram & Ry Wld—June 6, 1907. No. 85167 B.

London Tubes.

The Charing Cross, Euston & Hampstead Railway. Illustrated description of this new line, "the last link" in the system of underground tube railways in London. 2000 w. Elect'n, Lond—May 31, 1907. Serial. 1st part. No. 84885 A.

Motors.

Calculation and Examination of the Characteristic Curves of Direct- and Alternating-Current Series Motors with Regard to the Requirements of Electric Traction (Vorausberechnung und Beurteilung der Charakteristischen Kurven von Seriemotoren für Gleichstrom und Wechselstrom hinsichtlich der Bedürfnisse der Elektrischen Traktion). W. Kummer. Mathematical paper. Ills. Serial. 2 parts. 4500 w. Schweiz Bau —May 18 and 25, 1907. No. 84965 each B.

Recent Improvements in Motor and Control. Clarence Renshaw. Read before the N. Y. State St. Ry. Assn. Considers interpole motors, unit switch control, and the single-phase system. Ills. 5000 w. St Ry Jour—June 29, 1907. No. 85369.

Recent Improvements in Motor and Control. G. H. Hill. Read before the N. Y. State St. Ry. Assn. Considers various points of improvement in design. 3000 w. St Ry Jour—June 29, 1907. No. 85368.

Power Plants.

New Power Plant of the Central Pennsylvania Traction Co. at Harrisburg, Pa. A new plant of about 2,000 kw. capacity is illustrated and described. 2000 w. Eng Rec—June 8, 1907. No. 84854.

New Power Plant of the Pittsfield Electric Street Railway Company. This steam-driven power station is illustrated and described as an interesting example of standard reciprocating engine practice for operating a small system economically. 2000 w. St Ry Jour—June 22, 1907. No. 85208.

The Electricity Generating Station of the Great Eastern Railway Co. Illustrated description of the power station at Stratford, Eng., and of its equipment. 2500 w. Elect'n, Lond—June 7, 1907. No. 85106 A.

Preston, England, Electric Railway Run by City Refuse. Frank C. Perkins. Illustrates and describes an interesting destructor installation which generates steam for the supply of the electric tramway department of the municipality. 2500 w. Elec Rev, N Y—June 8, 1907. No. 84845.

Rolling Stock.

The Law of Economical Proportion as Applied to Tramway Rolling Stock. William R. Bowker. Deals with the numerical proportioning of different types and sizes of tramway cars. 2000 w. Cassier's Mag—June, 1907. No. 85182 B.

Shops.

New Shops and Shop Practice of the Omaha & Council Bluffs Street Railway Company. An illustrated account of these shops and the practice in them. 2500 w. St Ry Jour—June 22, 1907. No. 85207.

Single-Phase.

The Single-Phase Railroad of the Brembana Valley (Italy). E. A. Kerbaker. Illustrated detailed description of this new line and its operation. 2000 w. Elec Rev, Lond—May 31, 1907. No. 84882 A.

Stations.

Report of the Cambridge Subway Stations. Abstract of an exhaustive report submitted by William Barclay Parsons upon the question of station locations. 2500 w. St Ry Jour—June 15, 1907. No. 85066.

Systems.

A Comparison of Electric Railway Systems (Vergleich Elektrischer Bahnsysteme). H. M. Hobart. Compares the efficiency of direct-current and single-phase, alternating-current systems. Curves. 4400 w. Elektrotech u Maschinenbau—May 12, 1907. No. 84976 D.

Three-Phase.

Notes on Three-Phase Traction. Gerard B. Werner. Discusses the electrification problem in general, the structural features of the three-phase locomotive, speed control, etc. 4000 w. Sch of Mines Qr —April, 1907. No. 85021 D.

Tracks.

Track Reconstruction in San Francisco. Illustrates and describes the standard track now being built, and some of the labor-saving methods that have been employed in the work. 1400 w. Elec Ry Rev—June 1, 1907. No. 84726.

Trolley.

The Bow Trolley. Gerald Hooghwinkel. Refutes remarks by Eugen Eichel in an earlier article, and explains advantages of the bow. 1200 w. Elec Rev, Lond—June 7, 1907. No. 85101 A.

Trunk Lines.

Electric Trunk-Line Operation (Der Elektrische Vollbahnbetrieb). Ph. Pforr. Discusses principally 'the Prussian and Hessian State Railway. Ills. 7500 w. Glasers Ann—May 15, 1907. No. 84958 D.

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EXPLANATORY NOTE- THE ENGINEERING INDEX.

We hold ourselves ready to supply—usually by return of post—the full text of every article indexed in the preceding pages, *in the original language*, together with all accompanying illustrations; and our charge in each case is regulated by the cost of a single copy of the journal in which the article is published. The price of each article is indicated by the letter following the number. When no letter appears, the price of the article is 20 cts. The letter A, B, or C denotes a price of 40 cts.; D, of 60 cts.; E, of 80 cts.; F, of $1.00; G, of $1.20; H, of $1.60. When the letter N is used it indicates that copies are not readily attainable, and that particulars as to price will be supplied on application. Certain journals, however, make large extra charges for back numbers. In such cases we may have to increase proportionately the normal charge given in the Index. In ordering, care should be taken to *give the number* of the article desired, not the title alone.

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THE PUBLICATIONS REGULARLY REVIEWED AND INDEXED.

The titles and addresses of the journals regularly reviewed are given here in full, but only abbreviated titles are used in the Index. In the list below, *w* indicates a weekly publication, *b-w*, a bi-weekly, *s-w*, a semi-weekly, *m*, a monthly, *b-m*, a bi-monthly, *t-m*, a tri-monthly, *qr*, a quarterly, *s-q*, semi-quarterly, etc. Other abbreviations used in the index are: Ill—Illustrated: W—Words; Anon—Anonymous.

Alliance Industrielle. *m.* Brussels.
American Architect. *w.* New York.
Am. Engineer and R. R. Journal. *m.* New York.
American Jl. of Science. *m.* New Haven, U. S. A.
American Machinist. *w.* New York.
Annales des Ponts et Chaussées. *m.* Paris.
Ann. d Soc. Ing. e d Arch. Ital. *w.* Rome.
Architect. *w.* London.
Architectural Record. *m.* New York.
Architectural Review. *s-q.* Boston.
Architect's and Builder's Magazine. *m.* New York.
Australian Mining Standard. *w.* Melbourne.
Autocar. *w.* Coventry, England.
Automobile. *w.* New York.
Automotor Journal. *w.* London.
Beton und Eisen. *qr.* Vienna.
Boiler Maker. *m.* New York.
Brass World. *m.* Bridgeport, Conn.
Brit. Columbia Mining Rec. *m.* Victoria, B. C.
Builder. *w.* London.
Bull. Am. Iron and Steel Asso. *w.* Phila., U. S. A.
Bulletin de la Société d'Encouragement. *m.* Paris.
Bulletin of Dept. of Labor. *b-m.* Washington.
Bull. Soc. Int. d'Electriciens. *m.* Paris.
Bulletin of the Univ. of Wis., Madison, U. S. A.
Bulletin Univ. of Kansas. *b-m.* Lawrence.
Bull. Int. Railway Congress. *m.* Brussels.
California Jour. of Tech. *m.* Berkeley, Cal.
Canadian Architect. *m.* Toronto.
Canadian Electrical News. *m.* Toronto.
Canadian Engineer. *m.* Toronto and Montreal.
Canadian Mining Journal. *b-w.* Toronto.
Cassier's Magazine. *m.* New York and London.
Cement. *b-m.* New York.
Cement Age. *m.* New York.
Central Station. *m.* New York.
Chem. Met. Soc. of S. Africa. *m.* Johannesburg.
Colliery Guardian. *w.* London.
Compressed Air. *m.* New York.
Comptes Rendus de l'Acad. des Sciences. *w.* Paris.
Consular Reports. *m.* Washington.
Deutsche Bauzeitung. *b-w.* Berlin.

Domestic Engineering. *w.* Chicago.
Economic Geology. *m.* So. Bethlehem, Pa.
Eisenbahntechnische Zeitschrift. *b-m.* Berlin.
Electrical Age. *m.* New York.
Electrical Engineer. *w.* London.
Electrical Review. *m.* London.
Electrical Review. *w.* New York.
Electric Journal. *m.* Pittsburg, Pa.
Electric Railway Review. *w.* Chicago.
Electrical World. *w.* New York.
Electrician. *w.* London.
Electricien. *w.* Paris.
Electrochemical and Met. Industry. *m.* N. Y.
Elektrochemische Zeitschrift. *m.* Berlin.
Elektrotechnik u Maschinenbau. *w.* Vienna.
Elektrotechnische Rundschau. *w.* Potsdam.
Elektrotechnische Zeitschrift. *w.* Berlin.
Elettricità. *w.* Milan.
Engineer. *w.* London.
Engineer. *s-m.* Chicago.
Engineering. *w.* London.
Engineering-Contracting. *w.* New York.
Engineering Magazine. *m.* New York and London.
Engineering and Mining Journal. *w.* New York
Engineering News. *w.* New York.
Engineering Record. *w.* New York.
Eng. Soc. of Western Penna. *m.* Pittsburg, U. S. A.
Far Eastern Review. *m.* Manila, P. I.
Fire and Water. *w.* New York.
Foundry. *m.* Cleveland, U. S. A.
Génie Civil. *w.* Paris.
Gesundheits-Ingenieur. *s-m.* München.
Giorn. dei Lav. Pubb. e d Str. Ferr. *w.* Rome.
Glaser's Ann. f Gewerbe & Bauwesen. *s-m.* Berlin.
Heating and Ventilating Mag. *m.* New York.
Ice and Refrigeration. *m.* New York.
Industrial World. *w.* Pittsburg.
Ingeniería. *b-m.* Buenos Ayres.
Ingenieur. *w.* Hague.
Insurance Engineering. *m.* New York.
Int. Marine Engineering. *m.* New York.
Iron Age. *w.* New York.
Iron and Coal Trades Review. *w.* London.
Iron and Steel Trades Journal *w.* London.
Iron Trade Review. *w.* Cleveland, U. S. A.
Jour. of Accountancy. *m.* N. Y.
Journal Asso. Eng. Societies. *m.* Philadelphia.
Journal of Electricity. *m.* San Francisco.
Journal Franklin Institute. *m.* Philadelphia.
Journal Royal Inst. of Brit. Arch. *s-qr.* London.
Jour. Roy. United Service Inst. *m.* London.
Journal of Sanitary Institute. *qr.* London.
Jour. of South African Assn. of Engineers. *m.* Johannesburg, S. A.
Journal of the Society of Arts. *w.* London.
Jour. Transvaal Inst. of Mech. Engrs., Johannesburg, S. A.
Jour. of U. S. Artillery. *b-m.* Fort Monroe, U. S. A.
Jour. W. of Scot. Iron & Steel Inst. *m.* Glasgow.
Journal Western Soc. of Eng. *b-m.* Chicago.
Journal of Worcester Poly. Inst., Worcester, U. S. A.
Locomotive. *m.* Hartford, U. S. A.
Machinery. *m.* New York.
Madrid Cientifico. *t-m.* Madrid.
Manufacturer's Record. *w.* Baltimore.
Marine Review. *w.* Cleveland, U. S. A.
Men. de la Soc. des Ing. Civils de France. *m.* Paris.
Métallurgie. *w.* Paris.
Minero Mexicano. *w.* City of Mexico.
Mines and Minerals. *m.* Scranton, U. S. A.
Mining and Sci. Press. *w.* San Francisco.
Mining Journal. *w.* London.
Mining Reporter. *w.* Denver, U. S. A.
Mittheilungen des Vereines für die Förderung des Local und Strassenbahnwesens. *m.* Vienna.
Motor Wagon. *w.* Cleveland, U. S. A.
Municipal Engineering. *m.* Indianapolis, U. S. A.
Municipal Journal and Engineer. *w.* New York.
Nature. *w.* London.
Nautical Gazette. *w.* New York.
New Zealand Mines Record. *m.* Wellington.
Oest. Wochenschr. f. d. Oeff. Baudienst. *w.* Vienna.
Oest. Zeitschr. Berg & Hüttenwesen. *w.* Vienna.
Plumber and Decorator. *m.* London.
Popular Science Monthly. *m.* New York.
Power. *m.* New York.
Practical Engineer. *w.* London.
Pro. Am. Soc. Civil Engineers. *m.* New York.
Pro. Canadian Soc. Civ. Engrs. *m.* Montreal.
Proceedings Engineers' Club. *qr.* Philadelphia.
Pro. St. Louis R'way Club. *m.* St. Louis, U. S. A.
Pro. U. S. Naval Inst. *qr.* Annapolis, Md.
Quarry *m.* London.
Queensland Gov. Mining Jour. *m.* Brisbane, Australia.
Railroad Gazette. *w.* New York.
Railway Age. *w.* Chicago.
Railway & Engineering Review. *w.* Chicago.
Railway and Loc. Engng. *m.* New York.
Railway Master Mechanic. *m.* Chicago.
Revista d Obras. Pub. *w.* Madrid.
Revista Tech. Ind. *m.* Barcelona.
Revue de Mécanique. *m.* Paris.
Revue Gén. des Chemins de Fer. *m.*- Paris.
Revue Gén. des Sciences. *w.* Paris.
Revue Industrielle. *w.* Paris.
Revue Technique. *b-m.* Paris.
Rivista Gen. d Ferrovie *w.* Florence.
Rivista Marittima. *m.* Rome.
Schiffbau. *s-m.* Berlin.
Schweizerische Bauzeitung. *w.* Zürich.
Scientific American. *w.* New York.
Scientific Am. Supplement. *w.* New York.
Sibley Jour. of Mech. Eng. *m.* Ithaca, N. Y.
Stahl und Eisen. *s-m.* Düsseldorf.
Stevens Institute Indicator. *qr.* Hoboken, U. S. A.
Street Railway Journal. *w.* New York.
Technograph. *yr.* Urbana, Ill.
Technology Quarterly. *qr.* Boston, U. S. A.
Tijds v h Klijk. Inst. v Ing. *qr.* Hague.
Tramway & Railway World. *m.* London.
Trans. Am. Ins. Electrical Eng. *m.* New York.
Trans. Am. Ins. of Mining Eng. New York.
Trans. Am. Soc. Mech. Engineers. New York.
Trans. Inst. of Engrs. & Shipbuilders in Scotland, Glasgow.
Transport. *w.* London.
Wood Craft. *m.* Cleveland, U. S. A.
Yacht. *w.* Paris.
Zeitschr. f. d. Gesamte Turbinenwesen. *w.* Munich.
Zeitschr. d. Mitteleurop. Motorwagon Ver. *s-m.* Berlin.
Zeitschr. d. Oest. Ing. u. Arch. Ver. *w.* Vienna.
Zeitschr. d. Ver. Deutscher Ing. *w.* Berlin.
Zeitschrift für Elektrochemie. *w.* Halle a S.
Zeitschr. f. Werkzeugmaschinen. *b-w.* Berlin.

CURRENT RECORD OF NEW BOOKS

NOTE—Our readers may order through us any book here mentioned, remitting the publisher's price as given in each notice. Checks, Drafts, and Post Office Orders, home and foreign, should be made payable to THE ENGINEERING MAGAZINE.

Architects' Directory.

The Architects' Directory and Specification Index. Compiled by William T. Comstock. Size, 10 by 7 in.; pp., 179. Price, $3. New York: William T. Comstock.

The eighth annual edition of this work. It contains a complete list of the architects in the United States and Canada, classified by states and towns, and the names of the officers and locations of the different architectural associations in the United States; a complete list of landscape and naval architects of the United States and Canada; a list of the building departments of the leading cities, with the names of the principal officers; together with a specification index of prominent dealers and manufacturers of building materials and appliances. The book has been carefully revised and in several departments this edition gives much fuller information than its predecessors.

Automobiles.

Self-Propelled Vehicles. By James E. Homans. Sixth edition, revised and enlarged. Size, 8 by 5 in.; pp., VII, 598. Ills., 500. Price, $2. New York: Theo. Audel and Company.

In undertaking the revision of this popular work for the present edition, the author has striven to meet the requirements of the motor-vehicle owner, operator and repairer. As stated in the preface, it would be impossible to completely review the whole field of automobile engineering in a single volume, and the present work "essays to discharge the function of a general introduction; a convenient guide book to the intricacies that must inevitably be encountered; a summary of the facts and principles that it is necessary to understand." The author has confined himself to the consideration of only the practical aspects of motor vehicles of all powers, to the discussion of matters fundamental in construction and management. Theoretical matters, of interest almost wholly to designers and builders, have been omitted except in cases where they are positively essential to a correct understanding. The principles of all the accessory parts of the automobile, igniters, carbureters, etc., are explained and illustrated by typical examples. The book with its large number of illustrations should prove of great value to the practical man and to the student of this branch of mechanical engineering.

Fireplaces.

Rumford Fireplaces, and How They Are Made. By G. Curtis Gillespie. Size, 8 by 5 in.; pp., 200. Ill. Price, $2. New York: William T. Comstock.

A reprint of Count Rumford's essay on fireplace construction, which still remains the standard work on the subject, introduced by a plea for a more general consideration of the form and proportion of this much neglected feature of building construction. The large number of excellent illustrations in the book make it of interest to the layman as well as to the architect.

Gas Engines.

Questions and Answers from *The Gas Engine*. Size, 7 by 5 in.; pp., 274. Ill. Price, $1.50. Cincinnati: *The Gas Engine* Publishing Co.

This little book has been compiled from the "Answers to Inquiries" column in *The Gas Engine*, and consists of the most interesting and valuable inquiries which have appeared in that journal during the last eight years. The inquiries have come almost entirely from men in actual charge of plants and the answers to them have, therefore, considerable interest and value for the practical man. The questions cover points relating to the design, construction, operation and repair of gas and gasoline engines for stationary, marine and automobile use, and also to gas producers. Probably the most valuable part of the book is the section on gas-engine troubles, in which many obscure points in gas-engine operation are cleared up and the cause of many of its annoying and troublesome tricks are briefly but clearly explained.

Machine Tools.

Modern American Machine Tools. By C. H. Benjamin. Size, 9 by 6 in.; pp., XIX, 320. Ills., 134. Price, $5 New York: E. P. Dutton and Company.

The author has endeavored to produce a book of value to the buyer and the man-

ufacturer of machine tools rather than to the apprentice or the journeyman. Instead of describing details of adjustment and operation, therefore, the book is concerned with the design and construction of the machines themselves. The object has been to give the prominent characteristics of modern tools as now manufactured in the United States, the various points in which they differ from one another, and recent data as to their capacity and performance. The manufacturer of metal-working machinery will find the work one of interest and profit as showing the general trend of machine design and the more recent developments. Special machinery, such as is used for but limited lines of manufacture, has been excluded from the book, but planing, turning, boring, milling machines, in fact, all machines which would find use in a general machine shop, are fully and interestingly treated. The large number of excellent illustrations adds greatly to the clearness and value of the work.

Plumbing.

Modern Plumbing Illustrated. By R. M. Starbuck. Size, 10½ by 7½ in.; pp., 392. Plates, 55. Price, $4. New York: The Norman W. Henley Publishing Company.

An outgrowth of a series of plumbing charts published by the same author in 1899 and again in 1900. In their original form these publications consisted of seseries of blue prints illustrating various features of plumbing work and contained no letterpress whatever. For the present volume, new charts have been made, embodying the latest practice, and the value of the work has been greatly increased by the addition of several pages of descriptive matter to each chart. The work is designed to cover the whole field of plumbing as far as possible. The subjects considered range from the connections of fixtures and all other detail work to complete arrangements for all classes of public and private buildings in both town and country districts. Many tables are introduced, giving sizes and working data for all classes of work, and the final chapter, on "Suggestions for Estimating Plumbing Construction," rounds out a book which should be of great value to both the master plumber and the mechanic or apprentice.

Recipes.

Henley's Twentieth Century Book of Recipes, Formulas and Processes. Edited by Gardner D. Hiscox. Size, 9 by 6 in.; pp., 787. Ills., 25. Price, $3. New York: The Norman W. Henley Publishing Company.

The ten thousand formulas contained in this book have been compiled with a view to meeting the needs of the mechanic, artisan, manufacturer and housewife. The composition and preparation of nearly every substance used in any of the arts and manufactures are described and explained, together with those of a large number of substances of daily use in the household. Great care has been taken to include only recipes of known and tested value, and the compiler has drawn his information from the most authoritative sources available. The material is most conveniently arranged for ready reference. The subjects have been arranged in alphabetical order and the liberal use of cross-references makes the finding of information on any desired subject an easy task. Illustrations have been used wherever necessary to give a clearer idea of the subject under discussion. The entire policy of the editor has been to produce a book which might be considered "a repository of expert advice on every subject of technical importance."

BOOKS RECEIVED.

Report of the Commissioner of Public Roads, State of New Jersey, 1906. Size, 9 by 6 in.; pp., 176. Ills. Trenton, N. J.: Office of the Road Commissioner.

The Traveling Engineers' Association: Proceedings of the Fourteenth Annual Convention held August 28, 29, 30 anu 31, 1906, at Chicago, Ill. Size, 9 by 6 in.; pp., 414. Oswego, N. Y.: Published by the Secretary.

Mineral Resources of the United States, 1905. Published by the United States Geological Survey under the direction of David T. Day. Size, 9 by 6 in.; pp., 1403. Washington, D. C.: Department of the Interior.

Twentieth Annual Report of the Interstate Commerce Commission, 1906. Published under the direction of the Commission. Size, 9 by 6 in.; pp., 194. Washington, D. C.: Government Printing Office.

British Standard Specifications for Ingot Steel Forgings for Marine Purposes. Prepared by the Engineering Standards Committee and edited by the Secretary, Leslie S. Robertson. Size, 13 by 8 in.; pp., 10. Ills. Price, 2/6. London: Crosby Lockwood and Son.

British Standard Specifications for Steel Bars (for Use in Automatic Machines). Prepared by the Engineering Standards Committee and edited by the Secretary, Leslie S. Robertson. Size, 13 by 8 in.; pp., 13. Ills. Price, 2/6. London: Crosby Lockwood and Son.

Second Report of the Locomotive Committee on Standard Locomotives for Indian Railways. Prepared by the Engineering Standards Committee and edited by the Secretary, Leslie S. Robertson. Size, 13 by 8 in.; pp., 6. Plates, 13. Price, 10/6. London: Crosby Lockwood and Son.